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(54) **A masonry unit with variable physico-constructional heat insulation, and heat and moisture accumulation properties**

(57) The invention relates to building elements, in particular, to building masonry units with variable physico-constructional heat insulation, and heat and moisture accumulation properties. A masonry unit is proposed, containing two parts: part (A) un part (B), where part (A) contains unit outer walls (1), a number of cavities (2), adapted to be filled with heat insulating material, cavities (2) wall (3), which is perpendicular to heat flow direction and cavities (2) wall (4), which is parallel to heat flow direction; part (B) contains a number of cavities (6), adapted to be filled with phase transition material, and cavities (6) wall (5), where cross-section of cavities (2) is greater than of cavities (6) and the cavities (6) cross-sectional shape is such, that its perimeter is larger than the perimeter of the same cross-sectional area having rectangular shape.

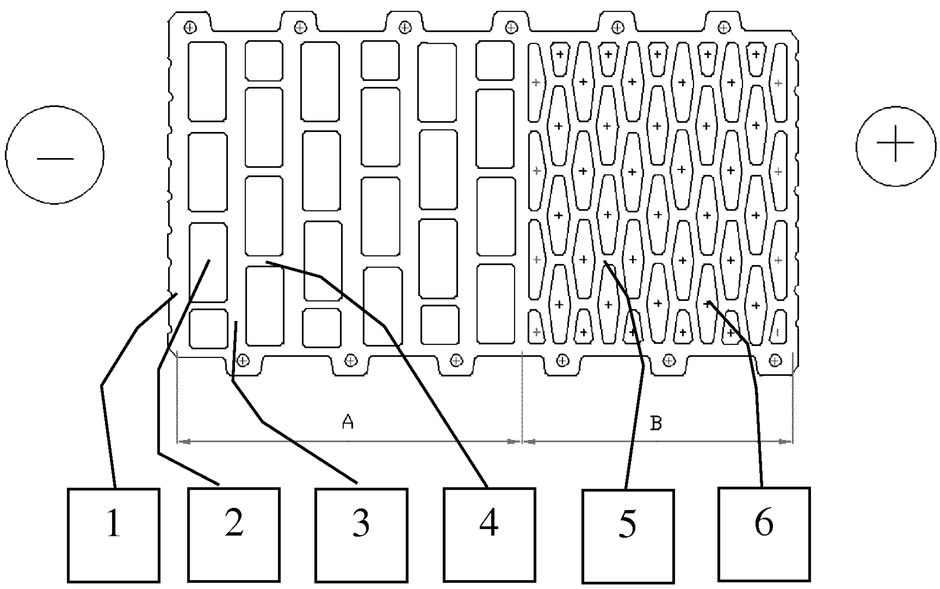

Fig. 1

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Description

Technical field

[0001] The invention relates to building elements in a shape of blocks or other shape, in particular, to building masonry elements with variable physico-constructional heat insulation, and heat and moisture accumulation properties, provided for ensuring the microclimate of the space in dynamic working conditions with minimal energy resources consumption.

Background Art

[0002] There are known building blocks - bricks, containing cavities filled with heat insulating material (DE3100642, FR2192226, DE2719860, GB2255117). Heat insulating properties of these blocks are much better than those of conventional perforated bricks.

[0003] There is known a block, containing cavities that are partially or completely filled with water-repellent mineral wool in cushion form (DE10058463). The main drawback of the known block is that its structure does not provide an adequate load-bearing capacity of the masonry wall construction, because of the area of masonry elements cavities relative to the total block area is more than 40%. This significantly exceeds the limits set by EN 1996-1-1, so it is not allowed to erect load-bearing delimiting constructions from these ceramic blocks using Eurocode Building Regulations EN 1996-1-1. In addition, the known block cannot be effectively used in conjunction with phase transition material - the arrangement of heat insulating material in the known block is symmetrical, both in an outer- and space-facing parts of the delimiting construction.

[0004] A building block is known, containing a number of internal regions with different structure and/or content (DE19741282). Some of said block regions contain cavities, filled with ceramic foam. Said regions are parallel to block side walls, adapted for holding of plaster layer. The main drawback of the block is that due to cavity covering approximately 1/3 of the block or an area that is >30% from the total area of the block, which cavity is designed in the centre of the element, it does not provide an adequate load-bearing capacity of the masonry wall constructions. This also exceeds the limitations set by EN 1996-1-1. In addition, the known block does not provide adequate efficacy of the space microclimate stabilization due to the arrangement of heat insulating material, which is symmetrical both in an outer- and space-facing parts of the delimiting construction. In addition the cavities of the space-facing part are not provided to be filled with phase transition material.

[0005] A building block is known (DE202005000723 U1) containing two parts. The extending-through holes are formed in the two parts, provided for filling therein heat insulating material. The cross-sectional area of holes of a first part are larger than the cross-sectional area of the holes of a second part, in addition, the ratio of cross-sectional area of the holes of the first part to the cross-sectional area of the holes of the second part is less than 10, preferably - less than 5. The total thickness of walls of the second part of block holes is 1.5-2.5 times larger than total thickness of walls of the block first part holes. The main drawback of the block is that the thickness of block walls is equal for both large and small cross-sectional holes and the vectors of their layout relative to the ceramic element symmetry axes does not provide increased masonry constructions resistance to tangential buckling deformations, because it does not provide an adequate increase of wall thickness in the direction of application of tangential buckling. In addition, when cross-sectional areas of the holes differ so significantly (for 1.5-2.5 times), in the course of forming blocks structural interfaces develop between flows of the material with significantly different speeds and pressures. After completion of forming process, when forming pressure is interrupted, the process of levelling of strain differences starts, induced by pressure, on interface of said flows, causing permanent deformations on the flows interfaces. During further technological processes of drying and baking these deformations increase, forms split in the ceramic walls and either destroy product or significantly reduce its strength.

[0006] In the construction sphere phase transition materials are used as well, containing substances with high melting enthalpy; substances capable of storing and releasing large amount of energy and under the effect of external factors (e.g., in the result of ambient temperature changes) changes in phases, e.g. - transfers from solid aggregative state to liquid or vice versa. In this way heat is absorbed or emitted (C. Castellón et.al. *"Use of Microencapsulated Phase Change Materials in Building Applications".* ASHRAE, 2007).

[0007] A building block is known (CN101196067) containing four walls, one of which is convex, and the parallel wall - is concave. Block contains three cavities, which are mutually separated by block internal walls. One cavity is adapted to be filled with phase transition material, and the two others - with heat insulating material. Block is provided with removable lid, adapted to cover the upper part of the block cavity containing phase transition material. The cavities for phase transition material are provided with reinforcing ribs adapted to hold said removable lid. A groove is formed at the centre of the block’s upper part, which coincides with the central longitudinal axis of the block; the block concave wall and the block convex wall also has corresponding grooves which coincide with vertical symmetry axis of these walls. Said grooves are adapted to receive reinforcement therein. The main drawback of the block is that one large cavity which is adapted to be filled with phase transition material does not provide efficient utilization of phase transition material. Firstly, due to the large thickness of the material layer, the heat coming from the material is difficult to convey to premises and remove from them. The impact of phase transition material to the space microclimate significantly depends on response rate. Large thickness of phase transition material significantly reduces the response rate. Secondly, thick layer of the phase transition material layer defines much higher costs of production. Thirdly, in the course of time under the effect of gravity force phase transition material becomes compacted; in the result a relatively large gap arises at the upper part of said large cavity, reducing the heat exchange and microclimate stabilization properties of the building block.

Disclosure of the invention

[0008] The aim of the invention is to eliminate the drawbacks of the prior art solutions and to propose a building block, provided to ensure set microclimate in premises in dynamic working conditions with minimum energy resources consumption.

[0009] The set aim is achieved by the proposed structure of the masonry building unit, where the masonry unit contains two parts: part (A) and part (B); part (A) contains outer walls of the unit, a number of cavities, adapted to be filled with heat insulation material, walls of the cavities, which are perpendicular to heat flow direction and walls of the cavities, which are parallel to heat flow direction; part (B) contains a number of cavities, adapted to be filled with phase transition material; the cross-sectional area of the part (A) cavities is larger than the cross-sectional area of the part (B) cavities, where the cross-sectional shape of part (B) cavities is such, that its perimeter is larger than perimeter of the same cross-sectional area having rectangular shape, and the material volume of the walls of masonry unit parts (A) and (B) is in the ranges between 45% and 70% of the volume of cavities, and the volume ratio of the material and cavities in each of the parts (A, B) of the masonry unit is in the range between 1% and10%, preferably - between 4% and 6%.

[0010] One embodiment of the masonry building unit is shown in Fig. 1, which is the longitudinal section of the masonry unit.

[0011] The part A of the masonry unit is designed to be located in the outside-facing wall part of the building, and the part B - to be located in the inside-facing part. The part A of the unit contains the unit's outer wall 1. The part A contains cavities 2, and the part B - cavities 6. Cavities 2 and 6 are asymmetrical and, preferably - extending-through.

[0012] Cavities 2 are mutually separated from each other with walls 3 and 4. Walls 3 are perpendicular to the heat flow direction, and walls 4 - are parallel to the heat flow direction. According to the preferred embodiment the unit contains two or more parallel rows of the cavities 2 (e.g., as it is shown in Fig. 1), preferably from 3 to 7 rows. In addition, the preferable mutual arrangement of the cavities 2 in the part A of the unit - is staggered.

[0013] Cavities 2 have greater cross-section than cavities 6. Cavities 6 are separated from each other with walls 5. According to the preferred embodiment the unit contains three or more parallel rows of cavities 6 (e.g., as it is shown in Fig. 1), preferably from 4 to 15 rows. The preferable mutual arrangement of the cavities 2 in the part B of the unit - staggered.

[0014] The cavities of the part A are adapted to be filled with heat insulation material (e.g., glass or rock-wool, eco-wool, synthetic foam material - foam polystyrene, polyurethane or polyamide foam or geo-polymer foam with low volume weight). The cavities of the part B are adapted to be filled with material, containing the carrier of phase transition material and phase transition material pellets. A shredded fibre of mineral origin, such as rock-wool or glass-wool fibre, and plant-based fibre - hemp or flax sheave, eco-wool can be used as the carrier of the phase transition material. Said phase transition material is selected with the aim to achieve larger interval of thermal effect of the phase transition.

[0015] When masonry units are designed to be used for premises, where moisture content is to be stabilized (exhibition galleries, museums, libraries) - hygroscopic fibre (eco-wool, hemp fibre, wood-fibre, geo-polymer filling, gypsum mortar) is preferred. When the priority is stabilization of temperature in the premises and the moisture stabilization is not required, mineral fibres and materials without expressed hygroscopic properties (rock or glass wool fibres sealing, fast-setting cement mortar or organic polymers) are preferred. Geo-polymer mineral foam also can be used as phase transition material. In this case foam can have higher volume weight than foam, provided as a filling for the outer-wall facing part of the block.

[0016] The division and filling of the cavities of the parts A and B of the unit can be varied depending on designed energy efficiency of premises, heat and moisture change intensity and the planned comfort categories level of microclimate in premises.

[0017] For premises with high energy efficiency requirements the increased thickness of outer heat insulating layer is preferred. For premises with increased microclimate criteria the thickness of the space internal heat and moisture accumulating and stabilizing layer is preferred.

[0018] The proposed masonry unit can be ceramic. The volume ratio of the ceramic element's wall material in the parts A and B of the block is equal and ranges between 45% and 70% of the volume of the cavities, wherein the allowed difference of the volume part of cavities in the parts A and B does not exceed 10%, preferably does not exceed 5%. This provides a possibility for making units by extrusion of clay and burnt-out additives paste, using traditional building ceramics technical equipment.

[0019] The increased cross-sectional area of the masonry unit part A cavities 2 allows to fill them by heat insulating material with less degree of compression. For this purpose both - preformed cores of corresponding size from heat insulating material can be used, by inserting them in the cavities 2 by using core shove-in technique, and fibre pieces of corresponding length from heat insulating material, by inserting them in the cavities 2 (e.g., by filling shredded fibre in the cavities 2 on vibrating conveyor by rotating brushes).

[0020] According to the preferable embodiment, the cavities 2 of the part A of the masonry unit in cross-section have a rectangular shape, wherein the layout axis of the longitudinal side of the of the rectangular is parallel to the axis of the section of wall placement plan, and the length of the transverse side of the rectangular cavity 2 is ½ from the length of the cavity 2 longitudinal side. This construction provides a suspension of potential cold bridges, and economic benefits for the preparation of heat insulating cores of uniform size due to possibility to use a single core for filling the small aperture, and two cores for filling the large aperture, accordingly.

[0021] The preferred thickness of the walls 3 and 4 of the masonry unit part A cavities is ≥3 mm, preferably ≥ 5 mm, and thickness of the outer wall 1 of the unit is ≥ 5, preferably ≥ 8 mm. The thickness of the walls 4 of the cavities 2, when viewed parallel to the heat flow direction, is between 0.3 to 1, preferably 0.5 of the thickness of the walls 3 of the cavities 2, when viewed transverse to the heat flow direction. An observation of this condition ensures the static load resistance of the unit to buckling deformations and provides compliance of the unit to the requirements of Table 3.1. "Geometrical requirements for Grouping of Masonry Units", "EN 1996-1-1, set forth in "Eurocode 6 - Design of masonry structures - Part 1-1" for ceramic masonry units of the groups 2 and 3.

[0022] The reduced cross-sectional area of the masonry unit part B cavities 6 allows inserting there phase transition material with higher degree of compression. For this purpose fast-setting paste can be used prepared from phase transition material microgranules and mortar binder material (e.g. gypsum, fast-setting cement, fast-setting organic polymer or geo-polymer), and mixture from phase transition material microgranules and shredded fibre of mineral or organic origin (glass or rock wool, hemp fibre, wood-fibre and eco-wool, synthetic fibres with a fibre length ≤4 mm; shredded fibre in the block cavities can be filled on the vibrating conveyor by rotating brushes). An observation of this condition ensures efficient realization of heat exchange process of the phase transition material in the space heat accumulation or emission.

[0023] The preferable shape of the unit part B cavities 6 cross-section is trapezoidal or rhombic - with an increased surface area per volume unit.

[0024] As phase transition material can be used known microcapsules of phase transition materials, e.g.: Basf SE Micronal DS 5008 X (polymer dispersions for construction); Rubitherm Technologies GmbH Rubitherm SP 25 A8; Microtek Laboratories, Inc. MPCM 24, 24D , MPCM 18D; RGEES LLC, savEnrg PCM 21P.

Claims

1. A masonry unit containing two parts: part (A) and part (B), where

   - part (A) contains outer wall (1) of the unit, a number of cavities (2) adapted to be filled with heat insulating material, walls (3) of the cavities (2) being perpendicular to heat flow direction and walls (4) of the cavities (2) being parallel to heat flow direction;
   - part (B) contains a number of cavities (6) adapted to be filled with phase transition material, and walls (5) of the cavities (6), **characterized in that** the cavities (2) have larger cross-sectional area than cavities (6), wherein cavities (6) cross-sectional shape is such, that its perimeter is larger than the perimeter of the same cross-sectional area having rectangular shape, and the material volume of the parts (A) and (B) of the masonry unit walls (1, 3, 4, 5) is in the range between 45% and 70% from the volume of cavities (2, 6), and the volume ratio of masonry unit material and cavities (2, 6) in each of the parts (A, B) is in the range between 1% and 10%, preferably - between 4% and 6%.

2. The masonry unit according to claim 1, **characterized in that** thickness of the walls (4) is between 0.3 and 1, preferably 0.5 of thickness of the walls (3).

3. The masonry unit according to claim 1 or 2, **characterized in that** cavities' volume difference in the parts (A) and (B) does not exceed 10%, preferably - does not exceed 5%.

4. The masonry unit according to any of the preceding claims, **characterized in that** the cavities' (2) cross-section has rectangular shape, hereto the cavities' (2) longitudinal side is parallel to the wall's (1) longitudinal axis, and the length of the shortest side of the rectangular cavity (2) is 0.5 of the length of the cavity's (2) longitudinal side.

5. The masonry unit according to any of the preceding claims, **characterized in that** the cavities' (6) cross-section has trapezoidal or rhombic shape.

6. The masonry unit according to any of the preceding claims, **characterized in that** it contains two or more cavities (2) in parallel rows, preferably between three and seven rows or three and more cavities (6) in parallel rows, preferably between four to fifteen rows; the preferable mutual arrangement of the cavities (2) of the unit part (A) and preferable mutual arrangement of the cavities (6) of the unit part (B) - staggered.

7. The masonry unit according to any of the preceding

claims, **characterized in that** thickness of the walls (3) and (4) is ≥3 mm, preferably ≥ 5 mm, and thickness of the wall (1) is ≥ 5, preferably ≥ 8 mm.

8. The masonry unit according to any of the preceding claims, **characterized in that** the cavities (2) are filled with heat insulating material.

9. The masonry unit according to any of the preceding claims, **characterized in that** the cavities (6) are filled with phase transition material.

10. The masonry unit according to the claim 8 and/or 9, where heat insulation material is selected from the group containing: glass wool, rock-wool, eco-wool, foam polystyrene, polyurethane or polyamide foam or geo-polymer foam.

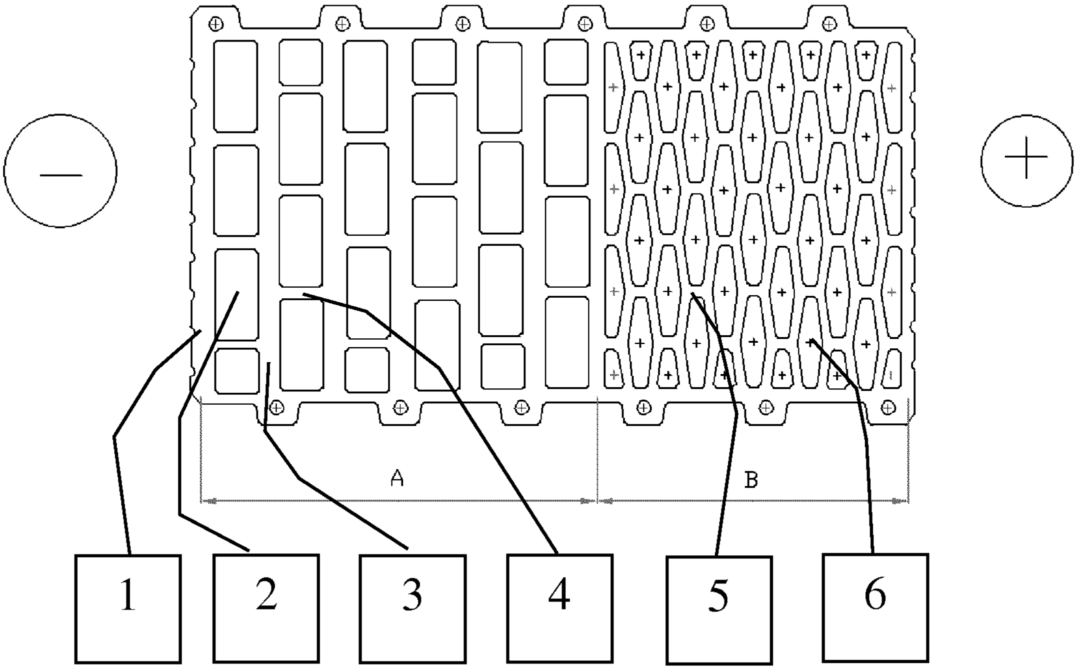

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 13 17 3542

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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	4 February 2014	Romosiou, Alexandra

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Application Number
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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
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