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(54) **SYSTEM FOR CIRCULATING AIR IN A STRUCTURE**

(57) The proposed solution describes a system for circulating air in a structure. The system comprises, between at least a first and a second structural layer of the structure, at least one outlet air channel to which overpressurized air is arranged to be conveyed, at least one inlet air channel from which underpressurized air is arranged to be removed, and at least one air-permeable air delivery structure, arranged between the outlet air channel and the inlet air channel. The air delivery structure is arranged to receive moisture and/or impurities possibly absorbed by the first and the second structural layer and to deliver air with moisture and/or impurities possibly carried thereby from the outlet air channel to the inlet air channel. Further, a method for circulating air in a structure by means of a system is described.

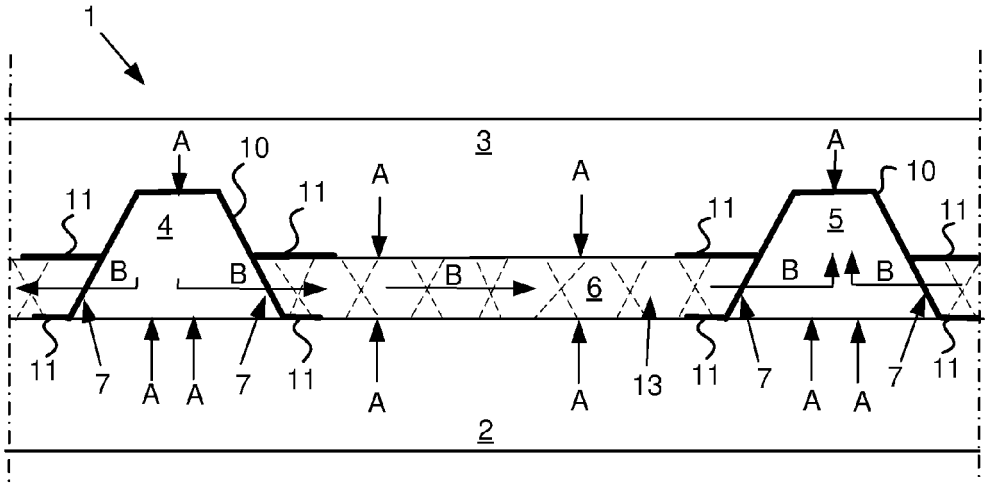

Fig. 1

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Description

BACKGROUND OF THE INVENTION

[0001] Various example embodiments generally relate to the drying of structures. Some example embodiments relate at least in part to a system for circulating air in a structure.

[0002] The drying of structures, such as concrete structures, is in scheduling terms one factor regulating the progression of work in construction. The concrete structures must be sufficiently dry before installing any coverings. There are various methods for drying structures, but these methods may be further developed.

SUMMARY OF THE INVENTION

[0003] The object of the invention is to develop a new method for circulating air in a structure and a system implementing the method, which are characterized by what is stated in the independent claims. Some preferred embodiments of the invention are claimed in the dependent claims.

[0004] The example embodiments of the proposed solution enable drying of a structure quickly for example after concrete casting, which considerably shortens construction time and improves quality of construction. The concrete casting may be thin without sacrificing load-carrying capacity of the structure. Dry and/or warm air is conveyed to the system, whereby moisture possibly absorbed by the structure is able to transfer to the air circulated in the system, and the structure may be dried completely. Also moisture arising from a possible water damage or from other sources of moisture during use of the structure may be easily removed without the moisture causing damage to health. The system may also be used for the removal of impurities, such as for example harmful volatile organic compounds (VOC), unpleasant odours and/or radon.

[0005] By means of the method and system according to the invention it is also possible to determine condition information of a structure from air circulated within the system. Moisture damages and/or impurities located anywhere in the structure may be detected by means of the system. By means of condition information measured by means of the system, possible leak damages may be detected and repaired before they cause more massive damages to the building and health hazards to people staying or living in the building. The system may be provided with sensors by means of which the place of a moisture damage in the building may be quickly located and restricted to a specific area. The structure may be dried while obtaining real-time monitoring information about drying of the structures. Further, the system determining condition information of the structure is a good tool for monitoring moisture and/or impurities present in the structures of a building during the entire life cycle of the building, also during time after construction, and it does not need to be limited merely to construction-time monitoring.

[0006] A first solution may comprise a system for circulating air in a structure, which system may comprise, between at least a first and a second structural layer of the structure, at least one outlet air channel to which overpressurized air may be arranged to be conveyed; at least one inlet air channel from which underpressurized air may be arranged to be removed; and at least one air-permeable air delivery structure, which may be arranged between the outlet air channel and the inlet air channel to receive moisture and/or impurities possibly absorbed by the first and the second structural layer; and to deliver air with moisture and/or impurities possibly carried thereby from the outlet air channel to the inlet air channel.

[0007] According to an example embodiment of the first solution, at least one outlet air channel may comprise at least one housing structure at least partly open from both ends and from a lower part thereof and at least one ventilation opening on at least one side of the housing structure, which ventilation opening may be arranged to convey air from the outlet air channel to the air delivery structure; and at least one inlet air channel comprises at least one housing structure at least partly open from both ends and form a lower part thereof and at least one ventilation opening on at least one side of the housing structure, which ventilation opening may be arranged to convey air having flown through the air delivery structure into the inlet air channel.

[0008] According to an example embodiment of the first solution, the size and shape of at least one ventilation opening may be arranged to adjust the rate of airflow leaving the outlet air channel and/or coming from the inlet air channel.

[0009] According to an example embodiment of the first solution, at least one ventilation opening may comprise a guide, which may be arranged to direct air coming into the outlet air channel towards the ventilation opening; and/or air coming from the ventilation opening of the inlet air channel out from the inlet air channel.

[0010] According to an example embodiment of the first solution, the system may comprise an adjustment system, which may be arranged to adjust the volume of air coming into at least one outlet air channel; and/or the volume of air leaving at least one inlet air channel.

[0011] According to an example embodiment of the first solution, the housing structure of the outlet and/or the inlet air channel may also comprise at least one drying opening, which may be arranged to convey moisture and/or impurities possibly absorbed by at least the first and/or the second structural layer to the air circulated in the system.

[0012] According to an example embodiment of the first solution, at least one drying opening may comprise a protective material to prevent clogging of the drying opening.

[0013] According to an example embodiment of the first solution, at least one air delivery structure may be

at least partly a load-carrying structure.

[0014] According to an example embodiment of the first solution, at least one air delivery structure may comprise at least one opening, which may be arranged to be filled with material of the second structural layer.

[0015] According to an example embodiment of the first solution, the air delivery structure may cover at least partly the space between the outlet and the inlet air channel.

[0016] According to an example embodiment of the first solution, at least one air delivery structure may be a mat structure.

[0017] According to an example embodiment of the first solution, at least the first and/or the second structural layer may comprise a concrete structure.

[0018] According to an example embodiment of the first solution, the first structural layer may comprise at least one of the following: a hollow-core slab, a steel beam reinforced with concrete-fill-casting or a concrete casting.

[0019] According to an example embodiment of the first solution, the outlet and the inlet air channel as well as the air delivery structure may be over the first structural layer; and the second structural layer may be at least partly over the outlet and the inlet air channel and the air delivery structure.

[0020] A second solution may comprise a method for circulating air in a structure by means of a system, which system may comprise, between at least a first and a second structural layer, at least one outlet air channel, at least one inlet air channel and at least one air-permeable air delivery structure, which air delivery structure may be arranged between the outlet air channel and the inlet air channel, in which method overpressurized air may be conveyed to at least one outlet air channel; underpressurized air may be removed from at least one inlet air channel; and at least one air delivery structure may receive moisture and/or impurities possibly absorbed by the first and the second structural layer; and deliver air with moisture and/or impurities possibly carried thereby from the outlet air channel to the inlet air channel.

DESCRIPTION OF THE FIGURES

[0021] The invention will now be described in more detail in connection with preferred embodiments, with reference to the accompanying drawings, in which

Fig. 1 partially illustrates one system for drying a structure according to an example embodiment;

Fig. 2 illustrates one housing structure of an outlet and/or an inlet air channel according to an example embodiment; and

Fig. 3 illustrates one method for drying a structure by means of a system according to an example embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0022] The detailed description of the invention given below with reference to the examples of the figures discloses various implementations of the invention. However, the invention is not limited merely to these examples, but the embodiments of the invention may vary within the scope of the claims.

[0023] According to one example embodiment, a system for circulating air in a structure comprises, between at least a first and a second structural layer of the structure, at least one outlet air channel to which overpressurized air is arranged to be conveyed, at least one inlet air channel from which underpressurized air is arranged to be removed as well as at least one air-permeable air delivery structure. The air delivery structure may be arranged between the outlet air channel and the inlet air channel to receive moisture and/or impurities possibly absorbed by the first and the second structural layer and to deliver air with moisture and/or impurities possibly carried thereby from the outlet air channel to the inlet air channel.

[0024] According to one example embodiment, a structure, such as a floor, wall and/or ceiling structure, may be dried by the system. The structure is for example a concrete structure or some other porous structure, in which moisture is able to transfer by capillary force, diffusion or something else from one place to another within the structure.

[0025] The system may further comprise an air circulation apparatus, which may be arranged to blow air to the outlet air channel and to suck the air having circulated within the system out from the inlet air channel. The air circulation apparatus may further comprise a blower unit, which may blow air into the system, whereby an overpressure may be provided in the outlet air channel. The air circulation apparatus may further comprise a suction unit, which may suck air coming from the system out from the system, whereby an underpressure may be provided in the inlet air channel. According to one example embodiment, the air circulation apparatus may further comprise at least one of the following: a heating, drying, air purification and/or cooling apparatus. Dry air, which may be cold or warm, may be circulated in the system. The system may circulate air or other gaseous medium within a structure. In case the air circulation apparatus lacks the heating, drying, air purification and/or cooling apparatus, air conveyed from interior spaces of the building and/or directly from outside may be circulated in the system.

[0026] In case the air circulation apparatus comprises a drying feature, the incoming moist air in the structure may be dried by means of the drying apparatus and the dried air may be recirculated in the system. In the air circulation apparatus, different types of heat sources, such as for example electricity, a fireplace, district heating and/or a heat pump, may be used for drying and heating. Moisture, air and/or volatile organic compounds in

the structure may be able to transfer from the structure to the air circulated in the system. The structure of the outlet and inlet air channels as well as of the air delivery structure in the system enable direct contact for the circulated air to the surrounding structures, whereby the moisture in the structures may transfer to the circulated air.

[0027] According to one example embodiment, the outlet and/or the inlet air channel may be protected, coated or wrapped at least partly in an air-permeable protective material, such as for example in a protective fabric. This may prevent for example the running of fresh concrete through openings or open sides, for example the ventilation and/or the drying openings, and their clogging. In case the structure has moisture and/or volatile organic compounds, at least part of the circulated air may, according to one example embodiment, be removed to the outside, and new replacement air may be taken from outside and/or from indoor air in return. The air circulation apparatus may also purify air of volatile and organic compounds, for example by means of various filters. According to one example embodiment, all or at least part of the circulated air may be dried and moisture and/or volatile organic compounds may be removed therefrom.

[0028] According to one example embodiment, the system may also comprise a heating system, which may be installed in the structure. The heating system may comprise an electric resistance wire, an electric resistance network, water-circulating heating, warm-air piping or some other system suitable for heating. The heating system may be installed for example above the air delivery structure in the second structural layer.

[0029] According to one example embodiment, the structure may form a false floor. The false floor may comprise the first and the second structural layer. In making the structure, the second structural layer may be cast over the existing first structural layer. The first structural layer may comprise for example at least one of the following: a hollow-core slab, a steel beam reinforced with concrete casting, a concrete casting and/or a floor slab. The system comprising at least one outlet and inlet air channel and air delivery structure is installed over the first structural layer. The second structural layer may be installed over the system, for example by providing a thinnest possible surface casting, such as concrete casting. Since the second structural layer is thin, no thick channels may be installed within the second structural layer. The second structural layer is for example 5-8 cm thick. The height of the inlet and/or outlet air channels is for example 2-3 cm. The distance of the inlet and the outlet air channel from each other may depend for example on the cross-sectional area and/or length of the inlet and outlet air channels, the size of the ventilation openings, the volume of air blown into and removed from the outlet air channel, and/or the humidity and/or temperature of the circulated air. Drying of the second structural layer, for example a surface casting, may be a problem particularly if the structure therebelow is moist and transfers moisture upwards. This may prolong the drying time and slow down construction, but by means of the system also the first structural layer may be dried quickly.

[0030] According to one example embodiment, by the system between the first and the second structural layer, both of the underlying first structural layer, such as for example a load-carrying intermediate floor slab, and the second structural layer thereover, such as for example a floor slab, may be dried at the same time. The drying may be achieved by installing the thin draining and air-permeable air delivery structure over the first structural layer and at least partly between the outlet and inlet air channels. In the air delivery structure, the air may permeate the air delivery structure at least partly from all surfaces thereof. The air delivery structure may be vented by the inlet and outlet air channels installed on at least two edges thereof. The second structural layer, for example a casting, may be installed over at least one outlet and inlet air channel and air delivery structure. If necessary, the second structural layer, such as a casting may settle between the parts of the system and/or for example in openings provided in the air delivery structure. The circulated air may suck moisture and/or harmful compounds present in the first and the second structural layer. The air delivery structure may be a mat structure, such as for example a drainage mat. The air delivery structure may let moisture coming from the first and the second structural layer to pass through into air channels in the air delivery structure. The circulated air may permeate the air delivery structure at least partly from at least two air delivery structure sides thereof, whereby the air is able to flow from the outlet air channel to the air delivery structure and further from there to the inlet air channel. Further, the air may permeate the air delivery structure at least partly also from above and from below, whereby moisture and/or impurities are able to move from the first structural layer through a lower surface of the air delivery structure and from the second structural layer through an upper surface of the air delivery structure to the air channels in which the air is circulating and which extend within the air delivery structure. The air may permeate the air delivery structure at least partly from all sides thereof and/or from above and from below.

[0031] Within the air delivery structure there may be one or more air channels. The air channels may be of any shape, and they may extend within the air delivery structure in different arrangements. For example, the air channels may be straight channels between the outlet and inlet air channels, or they may extend in a zigzag within the air delivery structure. The air flowing in the air and moisture permeable inlet and outlet air channels as well as in the air delivery structure may suck and convey moisture and/or harmful substances present in the first and the second structural layer to the air circulated in the system and remove them from the structure. Thereby the structure dries and/or the harmful substances are removed from the structure efficiently.

[0032] According to one example embodiment, if the

second structural layer of the structure is coated or covered with a porous material, this may be done right away or very quickly after installing the second structural layer, for example a concrete casting. After installation of the coating or covering, the drying of at least the first and the second structural layer of the structure may be completed by means of the above-mentioned system, whereby installing an additional structural layer does not cause long delays in the construction. If the second structural layer is to be coated with an air-impermeable or with a low air-permeability material, for example a plastic flooring, the upper part of the structure, i.e., the second structural layer, may be dried completely or to a desired dryness. Then the covering may be installed. After installation of the covering, the rest of the structure, i.e., at least the first and/or the second structural layer, may be dried to full dryness during the construction and/or use of the building. Thus, a covering may be installed for example over a concrete structure very quickly after casting, which considerably speeds up the construction. The system may be left permanently within the structure, which enables drying of the structure also after the construction period. Thereby any moisture possibly absorbed into the structure during use of the building may be dried at any time during the life cycle of the building. Further, by means of the system, harmful compounds present in the structure may be removed over the full life cycle of the building.

[0033] The structure may have at least one outlet air channel to which overpressurized air is conveyed and at least one inlet air channel from which air may be sucked out from the structure. This may cause the air to flow from the overpressurized inlet air channel along the air channels of the air delivery structure to the underpressurized inlet channel from which the air containing moisture and/or harmful compounds may be conveyed at least partly out or dried and/or purified. The purified and/or dried air may be recirculated into the structure by means of the system. Due to the air-permeable structure of the air delivery structure and the airflows provided therein, the moisture and/or harmful compounds present below and above the air delivery structure may move along at least one air channel located in the air delivery structure to the underpressurized inlet air channel.

[0034] According to one example embodiment, the outlet and inlet air channels may have one or more ventilation openings. From the outlet air channel, the air is able to flow through at least one ventilation opening to the air-permeable air delivery structure and from there through at least one ventilation opening to the inlet air channel. According to one example embodiment, the air circulates from the outlet air channel via the air delivery structure to the inlet air channel within the structure and dries the structure and, if necessary, also warms the structure. Thereby the moisture and/or organic compounds present in the structure may transfer to the circulated air via the open structures provided in the outlet and inlet air channels as well as via the air and moisture permeable structure of the air delivery structure. Further, at least one outlet and/or inlet air channel may have at least one drying opening letting moisture and/or organic compounds present in the structure into the circulated air. The circulated air may be removed from within the structure via the inlet air channel.

[0035] A condition of the structure may be monitored in real time by placing sensors measuring the condition of the structure for example within a blower unit blowing air into at least one outlet air channel and/or within an air-sucking suction unit, whereby it is easy to replace and calibrate the sensor during use. At least one sensor may also be placed in the airflow, for example in the outlet and/or the inlet air channel and/or in the air delivery structure. At least one output value for air leaving to the structure may be measured, and at least one input value for air coming from the structure may be measured. Condition information of the structure may be determined on the basis of at least one measured output and input value. In the measurement of the output and the input value, at least one of the following may be measured: temperature, relative humidity, absolute humidity, amount of radon and/or at least one content of a volatile organic compound. For example, by measuring an input value for absolute humidity over a longer time period, a change taking place in the drying of the structure may be concluded.

[0036] According to one example embodiment, at least one outlet and inlet air channel and at least one air delivery structure are located directly over the underlying first structural layer and the second structural layer is located at least partly directly over underlying at least one outlet and inlet air channel and at least one air delivery structure. This may enable the drying of both the first and the second structural layer by at least one outlet and inlet air channel and at least one air delivery structure at the same time. Thereby, in order to dry several layers it is necessary to have only one channel system in one part of the structure. The channel system dries the structure at the same time from above as well as from below.

[0037] According to one example embodiment, the moisture and/or impurities present in the second structural layer are able to move through at least one side surface and/or upper surface of at least one outlet and inlet air channel to the air channels extending therein. The outlet and inlet air channels may have one or more openings on at least one side surface and/or upper surface.

[0038] According to one example embodiment, the moisture and/or impurities present in the second structural layer are able to move through an upper surface and/or at least one side surface of at least one air delivery structure to at least one air channel extending therein.

[0039] According to one example embodiment, at least one outlet and inlet air channel and/or at least one air delivery structure enable for the circulated air a direct contact to the second and the first structural layer located thereabove and therebelow. Thereby the moisture present in at least the first and the second structural layer

may transfer to the air circulated in at least one outlet and inlet air channel and at least one air delivery structure. The air may permeate at least one outlet and inlet air channel and/or at least one air delivery structure at least partly from at least one side thereof and/or from above and/or from below. Thereby the moisture and/or impurities may be able to move from the first structural layer through a lower surface of at least one outlet and inlet air channel and at least one air delivery structure. Further, the moisture and/or impurities may be able to move from the second structural layer through an upper surface and/or at least one side surface of at least one outlet and inlet air channel and/or at least one air delivery structure to the air channels extending within at least one outlet and inlet air channel and/or at least one air delivery structure. Further, at least one outlet and inlet air channel and air delivery structure may be located between the first and the second structural layer in the same plane directly over the first structural layer. Thereby a lower surface of at least one outlet and inlet air channel and air delivery structure is positioned directly over the first structural layer.

[0040] The system as described above may further comprise a measuring apparatus for condition information of the structure from air circulated in the system. The measuring apparatus may further comprise at least two sensors arranged in the system, in which system at least one sensor is arranged to measure at least one output value from air blown into the structure and at least one sensor is arranged to measure at least one input value from air leaving the system from within the structure. Finally, the measuring apparatus may be arranged to determine condition information of the structure on the basis of at least one output and input value.

[0041] Fig. 1 partially illustrates one system for drying a structure according to an example embodiment. The example of Fig. 1 illustrates a structure 1 comprising a first 2 and a second structural layer 3. According to one example embodiment, there may be at least two structural layers. The first and the second structural layer 2, 3 may comprise for example a concrete structure. The first structural layer 2 may comprise for example a concrete slab and the second structural layer 3 may comprise for example a concrete casting.

[0042] Further, the structure 1 may comprise a system for drying and/or purifying the structure 1 by circulating air in the structure 1. The system 1 may comprise, between at least the first and the second structural layer 2,3, at least one outlet air channel 4 to which overpressurized air is arranged to be conveyed as well as at least one inlet air channel 5 from which underpressurized air is arranged to be removed. Further, the system may comprise at least one air-permeable air delivery structure 6, which may be arranged at least partly between the outlet air channel 4 and the inlet air channel 5. Further, the air delivery structure 6 may be arranged to receive moisture and/or impurities possibly absorbed by the first and the second structural layer 2,3 as well as to deliver air with moisture and/or impurities possibly carried thereby from the outlet air channel 4 to the inlet air channel 5. In the example of Fig. 1, arrow B indicates the air circulation direction within the structure 1 in the system. Arrows A indicate the direction of movement of moisture and/or impurities from the structures to the air circulation system. In the structure 1 there may be one or more structural layers above and/or below at least one inlet and outlet air channel 4, 5 and air delivery structure 6. The structural layers may be of the same or different material.

[0043] According to one example embodiment, the outlet and the inlet air channel 4,5 as well as the air delivery structure 6 are arranged over the first structural layer 2 and the second structural layer 3 is arranged over at least the outlet and the inlet air channel 4,5 and the air delivery structure 6 and/or interlaced therewith.

[0044] While the example of Fig. 1 shows only one outlet and inlet air channel 4,5, there may be more outlet and inlet air channels 4,5 installed within the structure 1. In this case, one outlet air channel 4 may feed air to air delivery structures 6 located on both sides thereof via at least one ventilation opening 7. The inlet air channel 5 may suck air from air delivery structures 6 located on both sides thereof via at least one ventilation opening 7.

[0045] According to one example embodiment, the air delivery structure 6 covers at least partly the space between the outlet air channel 4 and the inlet air channel 5. The air delivery structure 6 is for example a mat structure. This type of air delivery structure 6 may be for example a drainage mat. The drainage mat may carry the weight of concrete casting without, however, clogging its porous surface structure. The porous surface allows air to pass through the upper and the lower surface of the drainage mat. One or more air delivery structures 6 may be installed between the outlet and the inlet air channels 4,5. The air delivery structure 6 may be air-permeable, but the structure may not, however, allow for example the cast concrete coming thereover to penetrate into air channels 13 thereof and clog them. A separate protective material 9, such as for example a protective fabric, may also be provided over and/or under the air delivery structure to prevent the material of the second structural layer from clogging the air channels 13.

[0046] The air delivery structure 6 may carry the weight of the second structural layer, such as concrete casting, provided thereabove and/or interlaced therewith. According to one example embodiment, at least one air delivery structure 6 is at least partly a load-carrying structure. Thereby the air delivery structure 6 carries well the weight of the structural layer coming thereover. According to one example embodiment, at least one air delivery structure 6 comprises at least one opening arranged to be filled with material of the structural layer coming thereover. The second structural layer 3 may be cast for example over at least the outlet and the inlet air channel 4,5 and the air delivery structure 6. Further, the second structural layer 3 may be cast for example into openings provided in the air delivery structure 6. Thus, for example

in the casting stage, the concrete may fill at least one opening of the air delivery structure 6, which may increase the load-carrying capacity and strength of the structure. This also allows for a thinner second structural layer 3. This may be important for example in renovation, where one may have to cast over an existing floor another slab which is to be as thin as possible such that the floor level need not be raised unnecessarily.

[0047] The example of Fig. 1 shows arrows A, which indicate how moisture and/or impurities move towards the outlet and inlet air channels 4,5 and towards the air delivery structure 6 by the action of air circulated within the system.

[0048] Fig. 2 illustrates one housing structure 10 of an outlet and/or an inlet air channel according to an example embodiment. According to one example embodiment, at least one outlet air channel 4 and/or at least one inlet air channel 5 comprises at least one housing structure 10 at least partly open from both ends thereof and from at least one side. Housing structures 10 may be combined to form a channel 4,5 of a desired length. The housing structure 10 may comprise an upper part 14 and a lower part 15 as well as sides 16. The end parts 17 of the housing structure may be at least partly open. The outlet and inlet air channels 4, 5 may be arranged to receive moisture and/or impurities possibly absorbed by the first and the second structural layer 2,3 and to deliver air with moisture possibly carried thereby. The at least partly open lower part 15 of the housing structure may be positioned directly over the first structural layer 2. Thereby the at least partly open lower part 15 of the housing structure enables direct contact for the circulated air to the first structural layer 2, for example a concrete structure, located below the housing structure 10. The moisture and/or impurities present in the first structural layer 2 may transfer via the at least partly open lower part 15 of the housing structure to the air circulated in the system.

[0049] According to one example embodiment, there is at least one ventilation opening 7 on at least one side 16 of the housing structure 10 of the outlet air channel 4. At least one ventilation opening 7 may be arranged to convey overpressurized air from the outlet air channel 2 to the air delivery structure 6. The at least partly open lower part 15 of the housing structure 10 may be located on the underside of the housing structure against the first structural layer 2. At least one ventilation opening 7 of the housing structure may be located on at least one side 16 of the housing structure 10. In the example of Fig. 2, on both sides 16 of the housing structure there are two ventilation openings 7. The housing structure 10 may comprise a flap 11 located above and/or on the sides of at least one ventilation opening 7. The housing structure may be made of steel, plastic or other material having sufficient strength. The ventilation openings 7 may be formed by cutting the ventilation opening 7 in the lower edge of the housing structure 10 in such a way that the cut part is folded upwards so as to form a flap 11 extending parallel to the upper surface of the air delivery structure, which flap may be placed over the upper surface of the air delivery structure 6. At the same time, the parts adjacent to the ventilation opening 7 may be folded parallel to the lower part of the air delivery structure 6. Thereby the air delivery structure 6 may be supported from the upper and/or lower edge thereof between the flaps 11 provided above and adjacent to the ventilation opening 7. Thus, the air delivery structure 6 may be locked to at least one housing structure 10 and will not be able to move.

[0050] On at least one side 16 of the housing structure 10 of the inlet air channel 5 there may be at least one ventilation opening 7, which may be arranged to convey air having flown through the air delivery structure 6 into the underpressurized inlet air channel 5. According to one example embodiment, the system is arranged to adjust the rate of airflow leaving the outlet air channel 4 and/or coming from the inlet air channel 5. At least one ventilation opening 7 may comprise a guide arranged to direct air coming into the outlet air channel 4 towards the ventilation opening 7 and/or air coming from the ventilation opening 7 to the inlet air channel 5 out from the inlet air channel 5. The guide may be for example a guide plate or a projection, which may be installed at least partly in front of the ventilation opening 7 within the outlet and/or the inlet air channel 4,5 to direct the passage of air to a desired direction.

[0051] According to one example embodiment, the system comprises an adjustment system arranged to adjust the volume of air coming into at least one outlet air channel 4; and/or the volume of air leaving at least one inlet air channel 5. In this case, the adjustment system may adjust the volume of air coming into at least one ventilation opening 7 of at least one outlet air channel 4 and/or the volume of air leaving through at least one ventilation opening 7 of at least one inlet air channel 5.

[0052] According to one example embodiment, at least one housing structure 10 of the outlet and/or the inlet air channel 4,5 of the system comprises at least one drying opening 8 arranged to receive moisture possibly absorbed by at least the first and/or the second structural layer 2,3. The drying openings 8 may be located on different faces of the housing structure 10, for example on the sides 16 or in the upper part 14 of the housing structure. At least one drying opening 8 may convey moisture from the second structural layer to the air circulated in the outlet and/or the inlet air channel 4,5.

[0053] According to one example embodiment, a protective material 9 may be arranged at least partly over and/around the housing structure 10 of the outlet and the inlet air channel 4,5 of the system to prevent clogging of the lower part 15, at least one ventilation opening 7, the end part 17 and/or the drying opening 8. The protective material 9 may be for example a fabric mesh or some other suitable mesh structure. The drying opening 8 may also comprise a protective material 9 covering the drying opening 8.

[0054] Fig. 3 illustrates one method for circulating air

in a structure 1 by means of a system, the system comprising, between at least a first and a second structural layer 2,3, at least one outlet air channel 4, at least one inlet air channel 5 and at least one air-permeable air delivery structure 6 arranged between the outlet air channel 5 and the inlet air channel 5.

[0055] In step 300, overpressurized air may be conveyed to at least one outlet air channel 4.

[0056] In step 310, underpressurized air may be removed from at least one inlet air channel 5.

[0057] In step 320, at least one air delivery structure 6 may receive moisture and/or impurities possibly absorbed by at least the first and the second structural layer 2,3.

[0058] In step 330, at least one air delivery structure 6 may deliver air with moisture and/or impurities possibly carried thereby from the outlet air channel 4 to the inlet air channel 5.

[0059] According to one example embodiment, by means of the system the structure may be dried quickly, whereby the time spent for construction is reduced.

[0060] Other features of the method follow directly for example from the functions and parameters of the system, as described in the accompanying claims and in the entire specification, and are therefore not repeated herein. Different modifications of the methods may also be applied, as described in connection with various example embodiments.

[0061] All ranges or device values provided herein may be extended or changed without losing the desired effect. Further, any embodiment may be combined with another embodiment, unless explicitly disallowed.

[0062] Although the subject matter has been described using language specific to structural features and/or operations, it is to be understood that the subject matter defined in the accompanying claims is not necessarily limited to the above-described special features or operations. Rather, the above-described special features and operations are given as an example of implementing the claims, and other corresponding features and operations are intended to fall within the scope of the claims.

[0063] It is to be understood that the above-described advantages may relate to one embodiment or may relate to several embodiments. The embodiments are not limited to those that solve some or all of the stated problems, or to those that have some or all of the stated advantages. It is also to be understood that a reference to "a device or an assembly" may refer to one or more of these devices or assemblies.

[0064] The steps or operations of the methods described herein may be performed in any suitable order or simultaneously, if necessary. Further, individual steps may be removed from any method without departing from the scope of the subject matter described herein. The features of any embodiment described above may be combined with features of any other embodiment as described to form further embodiments without losing the desired effect.

[0065] It is obvious for a person skilled in the art that with the advancement of technology, the basic idea of the invention may be implemented in many different ways. The above specification, examples and information provide a description of the structure and use of the example embodiments. Although various embodiments have been described above on a specific level or with reference to one or more individual embodiments, persons skilled in the art can make numerous modifications to the presented embodiments without departing from the scope of application of this disclosure. The invention and its embodiments are thus not limited to the examples described above, but instead they may vary within the scope of the claims.

Claims

1. A system for circulating air in a structure (1), the system comprising, between at least a first and a second structural layer (2,3) of the structure (1),

   at least one outlet air channel (4) to which overpressurized air is arranged to be conveyed;
   at least one inlet air channel (5) from which underpressurized air is arranged to be removed; and
   at least one air-permeable air delivery structure (6), arranged

   between the outlet air channel (4) and the inlet air channel (5);
   to receive moisture and/or impurities possibly absorbed by at least the first and the second structural layer (2,3); and
   to deliver air with moisture and/or impurities possibly carried thereby from the outlet air channel (4) to the inlet air channel (5).

2. The system according to claim 1, wherein

   at least one outlet air channel (4) comprises at least one housing structure (10) at least partly open from both ends (17) and from a lower part (15) thereof and at least one ventilation opening (7) on at least one side (16) of the housing structure (10), arranged to convey air from the outlet air channel (4) to the air delivery structure (6); and
   at least one inlet air channel (5) comprises at least one housing structure (10) at least partly open from both ends (17) and from a lower part (15) thereof and at least one ventilation opening (7) on at least one side (16) of the housing structure (10), arranged to convey air having flown through the air delivery structure (6) into the inlet air channel (5).

3. The system according to claim 2, wherein the size and shape of at least one ventilation opening (7) are arranged to adjust the rate of airflow leaving the outlet air channel (4) and/or coming from the inlet air channel (5).

4. The system according to claim 2 or 3, wherein at least one ventilation opening (7) comprises a guide arranged to direct

    air coming into the outlet air channel (4) towards the ventilation opening (7); and/or
    air coming from the ventilation opening (7) of the inlet air channel (5) out from inlet air channel (5).

5. The system according to any one of the preceding claims 2-4, comprising an adjustment system arranged to adjust the volume of air coming into at least one outlet air channel (4); and/or the volume of air leaving at least one inlet air channel (5).

6. The system according to any one of the preceding claims 2-5, wherein at least one housing structure (10) of the outlet and/or the inlet air channel (4,5) comprises at least one drying opening (8) arranged to convey moisture and/or impurities possibly absorbed by at least the first and/or the second structural layer (2,3) to the air circulated in the system.

7. The system according to claim 6, wherein at least one drying opening (8) comprises a protective material (9) to prevent clogging of the drying opening (8).

8. The system according to any one of the preceding claims 1-7, wherein at least one air delivery structure (6) is at least partly a load-carrying structure.

9. The system according to any one of the preceding claims 1-8, wherein at least one air delivery structure (6) comprises at least one opening arranged to be filled with material of the second structural layer.

10. The system according to any one of the preceding claims 1-9, wherein the air delivery structure (6) covers at least partly the space between the outlet and the inlet air channel (4,5) .

11. The system according to any one of the preceding claims 1-10, wherein at least one air delivery structure (6) is a mat structure.

12. The system according to any one of the preceding claims 1-11, wherein at least the first and/or the second structural layer (2,3) comprises a concrete structure.

13. The system according to claim 12, wherein the first structural layer (2) comprises at least one of the following: a hollow-core slab, a steel beam reinforced with concrete-fill-casting and/or a concrete casting.

14. The system according to any one of the preceding claims 1-13, wherein

    the outlet and the inlet air channel (4,5) as well as the air delivery structure (6) are over the first structural layer (2); and
    the second structural layer (3) is at least partly over the outlet and the inlet air channel (4,5) and the air delivery structure (6).

15. A method for circulating air in a structure (1) by means of a system, the system comprising, between at least a first and a second structural layer (2,3), at least one outlet air channel (4), at least one inlet air channel (5) and at least one air-permeable air delivery structure (6), the at least one air delivery structure (6) being arranged between the outlet air channel (4) and the inlet air channel (5), in which method

    overpressurized air is conveyed (300) to at least one outlet air channel (4);
    underpressurized air is removed (310) from at least one inlet air channel (5); and
    at least one air delivery structure (6)

        receives (320) moisture and/or impurities possibly absorbed by at least the first and the second structural layer (2,3); and
        delivers (330) air with moisture and/or impurities possibly carried thereby from the outlet air channel (4) to the inlet air channel (5).

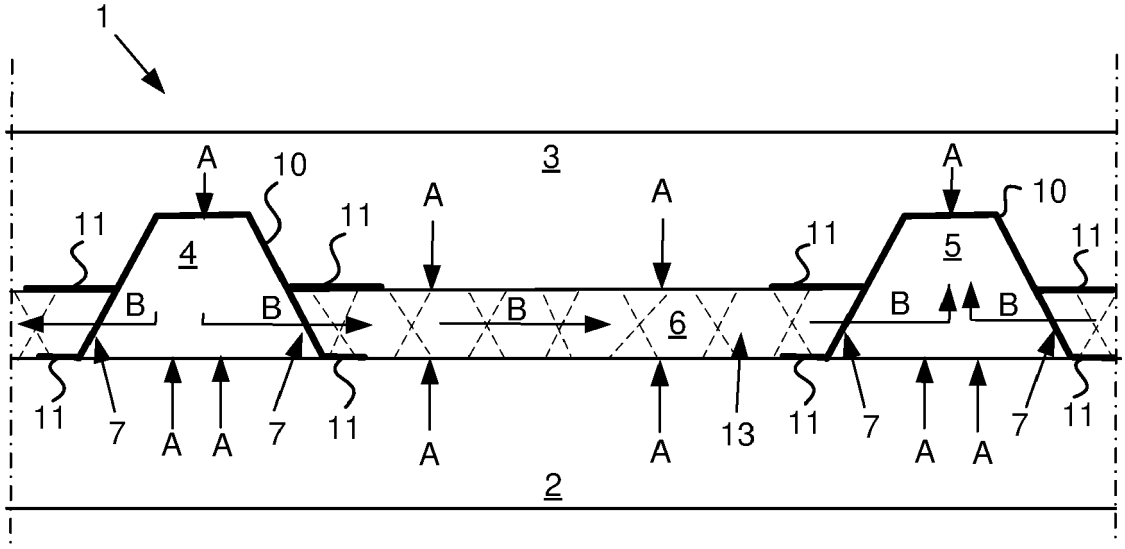

Fig. 1

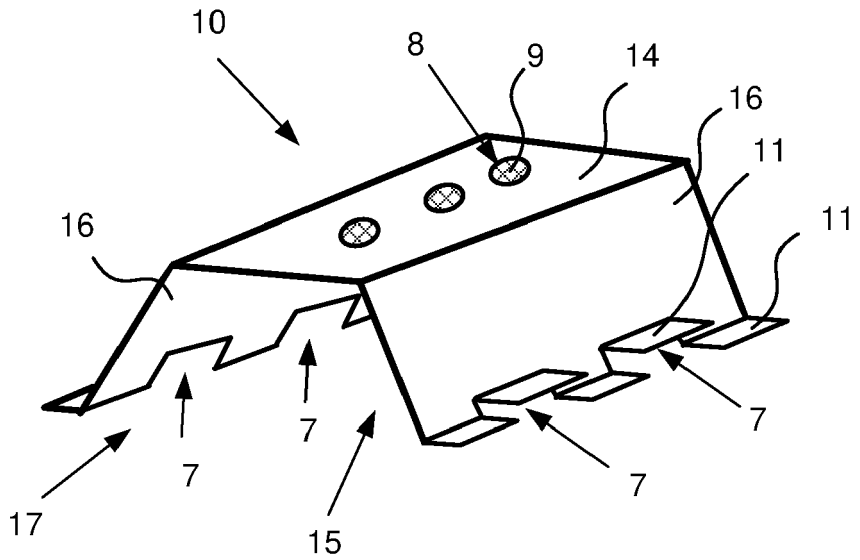

Fig. 2

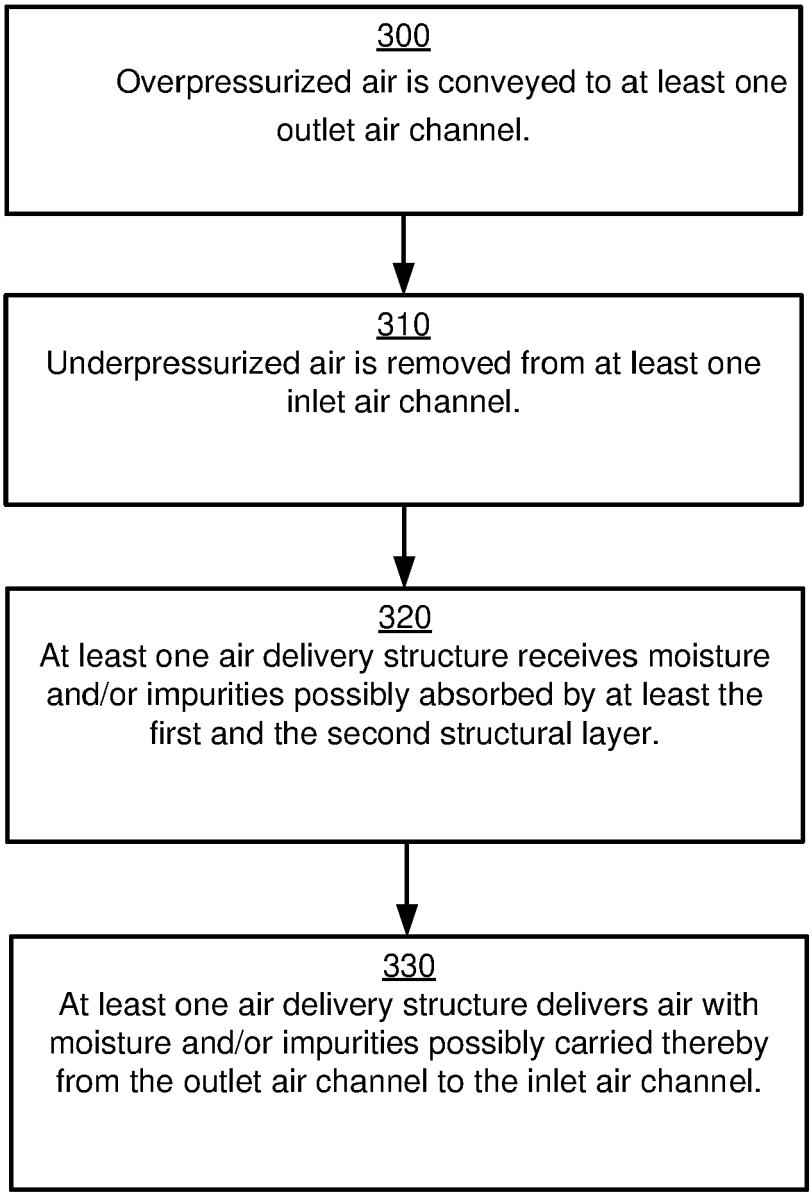
300
Overpressurized air is conveyed to at least one outlet air channel.
310
Underpressurized air is removed from at least one inlet air channel.
320
At least one air delivery structure receives moisture and/or impurities possibly absorbed by at least the first and the second structural layer.
330
At least one air delivery structure delivers air with moisture and/or impurities possibly carried thereby from the outlet air channel to the inlet air channel.

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 16 1232

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	4 July 2023	Petrinja, Etiel

CATEGORY OF CITED DOCUMENTS

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