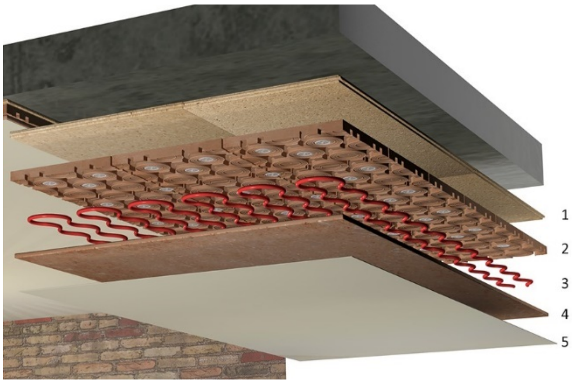
Natural climate ceilings in open modular design

The **water-guided natural climate ceiling system** from ArgillaTherm combines the advantages of innovative cooling/heating technology with the positive properties of clay as a building material and relies on a newly developed, globally unique and patented modular construction system.

Product manufacturing almost CO^2 neutral. 100% return to nature possible, cradle to cradle.

Sandwich construction



Components

1 OSB 3 / ESB-Plus P5 boards or cement-bonded chipboard with tongue and groove as substructure

2 High performance clay modules according to DIN 18948 and clay - neutral panels according to DIN 18948

3 Polybutene pipe "Hot & Cool" according to DIN 16968, PB 12 x 1.3mm, oxygen tight according to DIN 4726

4 Clay plaster according to DIN 18947 for surface heating and cooling systems with integrated mesh or natural lime base plaster 66-20 for surface heating systems and cooling systems with integrated mesh

5 Clay paint according to DVL TM 06 as sprayable and brushable ready-mix **or** mineral paint in accordance with VOB/C DIN 18363 Para. 2.4.1. as sprayable and brushable ready-mix

The heart of the system

High Performance Clay Modules

for easy & coupling-free installation of cooling/heating pipes.
Highly absorbent, dimensionally stable, crack-free, without the use of grid fabrics.
Moisture absorption according to standard = 107g/m^2 in 12 hours
Moisture absorption maximum > 500g/m^2
Tested and certified.

composition:
clays (≥ 35%), sands, brick dust, miscanthus fibres
1m^2 = 7.23 pieces high-performance clay modules

Research & Development

The natural climate ceiling system is tested and certified according to the latest European standards. The scientific background is unique! Among others, the MFPA Materials Research and Testing Institute at the Bauhaus University Weimar, the Fraunhofer Institute Holzkirchen, the Technical University Dresden and the Georg-August University Göttingen were involved in the development. Here, the product properties were investigated, defined and certified. These include performance, sorption properties, moisture storage and hygrothermal material characteristics. On request, reliable 2D simulations can now be produced by the TU Dresden on the moisture behavior during cooling and heating in the room and in the building components.

MFPA life cycle material engineering.

Material Research and Testing Institute at the Bauhaus University Weimar

Fraunhofer

Für digitalen Feuchteschutz-Nachweis nach
- ✓ DIN 4108
- ✓ DIN EN 15026
- ✓ ASHRAE 160

GWT forschung+innovation

TU Dresden

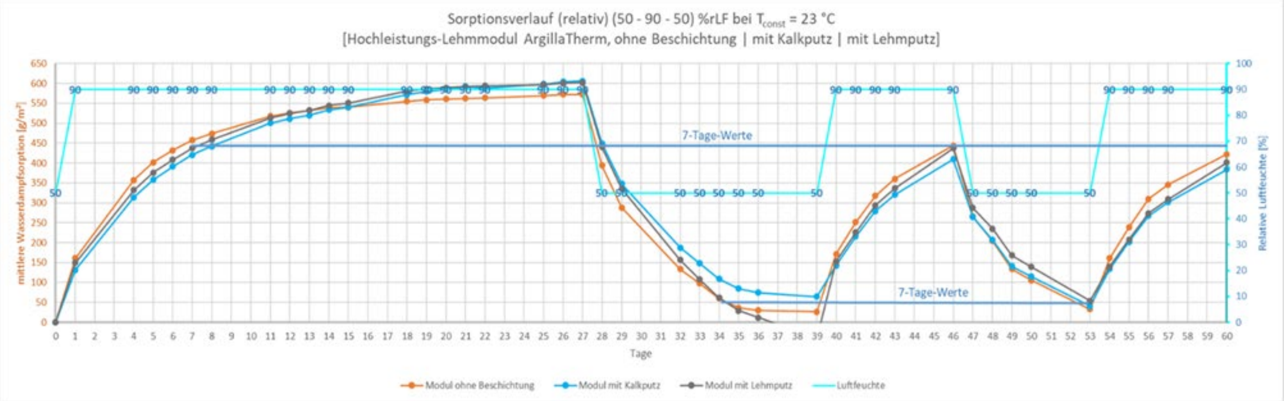
SNIC Südniedersachsen InnovationsCampus

Sorption properties

Various investigations into the sorption behavior (moisture regulation) of the High Performance Clay modules and the entire system were carried out at the Bauhaus University in Weimar and certified accordingly. Measurements were carried out according to standard specifications, as well as under more stringent conditions, such as increased moisture jumps or longer measurement intervals. A series of measurements with evaluation of the results is shown below.

Sorption long-term measurements with humidity jumps 50% - 90% - 50% (relative humidity rLF), carried out and tested by MFPA Weimar.

Test specimen: High-Performance Clay Modules without coating (light brown line).
High-Performance Clay Modules with clay plaster coating (dark brown line)
HighPerformanceLoam modules with natural lime plaster coating (blue line)



<u>Result of the measurements:</u>

The High Performance Clay modules can absorb more than 150 g of water vapor per m² within 24 hours and completely release it again within a very short time (desorption). After about 14 days, saturation is reached with a water vapor absorption of about 550g/m² at the simulated humidity jump of 40% rLF. No deformation, swelling or moisture penetration of the modules was observed, even over several weeks. The surface coatings (Argillatherm clay or lime plaster system) hardly influence the extreme sorption values of the High Performance Clay modules.

Hygrothermal material properties

determined by the Fraunhofer Institute

For the simulation of humidity in the room, the Fraunhofer Institute determined the hygrothermal material parameters of the High-Performance Clay modules and implemented a corresponding data set in the WUFI program.

The most important key figures:

Bulk density: 1,800 kg/m³

Porosity (dry): 31,9%

Free saturation: 319 kg/m³ (700 kg/m³ by swelling)

Water absorption coefficient A value: 1.6 kg/m²√h

Water vapor diffusion resistance: µ = 22 (23°C/50rLF), µ = 10 (23°C/93rLF)

Simulation of the moisture behavior in the room and in the masonry during cooling and heating

carried out by GWT (TU Dresden)

After coordination of the climatic conditions, constructions and materials, the room climate was first calculated using the THERAKLES software. This was used in the subsequent hygrothermal component simulations with DELPHIN. In the following, a simulation of the moisture behavior in the room and in the masonry during cooling and heating is shown without using mechanical dehumidification. The simulation runs over a period of 2 years.

Initial values:

Office space in Mannheim (region in Germany with the highest summer heat load).

Room area: 25 m² (5*5m), room height: 3 m

Room use: 2 persons on weekdays from 8 a.m. to 5 p.m.

Humidity load: 2 persons in the room with 80 g/h

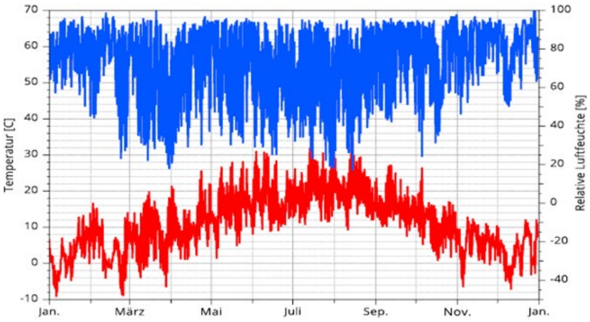
Windows: 4 m², facing south

Air exchange rate: permanent 0,6 1/h

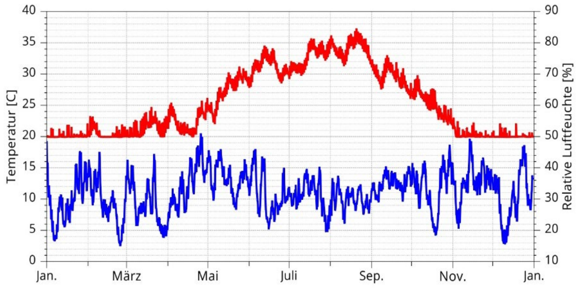
Parameters: VL = 14°C, room temperature = 26°C.

(≙ 78 Watt/m² power)

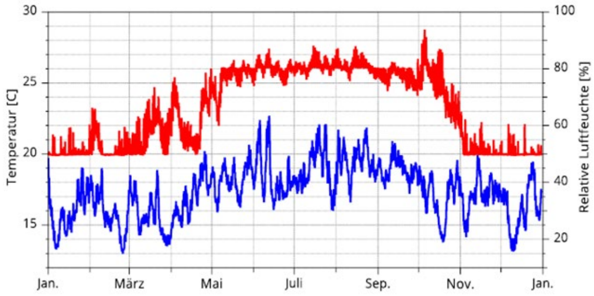
Cooling: 8h/day April to September



Außenklima in Mannheim



Temperature and humidity behavior in the room **without** cooling

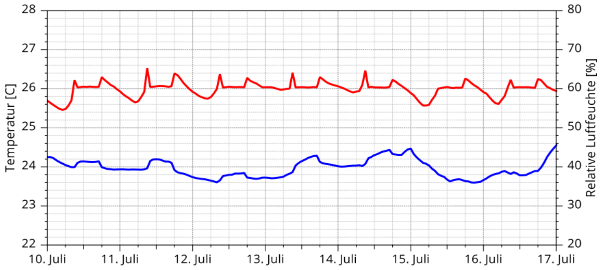


Temperature and humidity behavior in the room **with** cooling

During the week, it is noticeable that the cooling only runs for 8 hours, from 9:00 to 17:00. However, the use with the two people starts at 8:00 on weekdays, which is why the temperature in the room rises additionally.

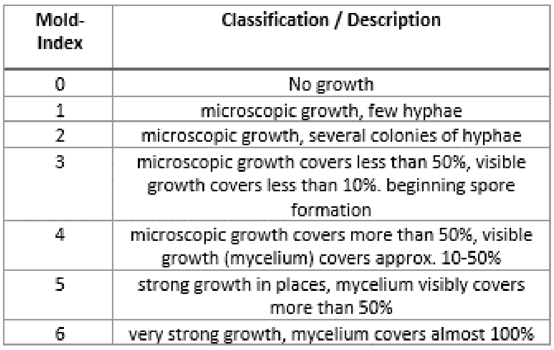
After the usage phase from 17:00, the people are no longer in the room and the ceiling cooling is switched off, which means that the external heat load is no longer absorbed.

Conclusion: The room humidity does not rise above 60% RH. A mechanical dehumidification is not necessary!



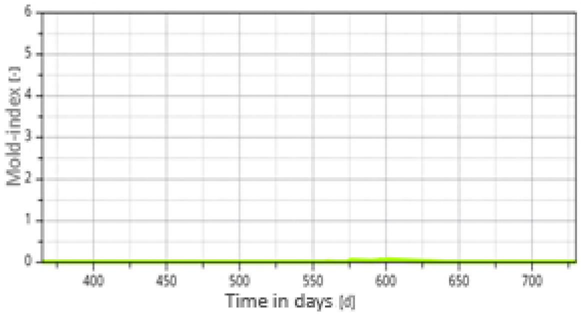
Course of the indoor climate during one week in July

Mold indexing



Mold-Index	Classification / Description
0	No growth
1	microscopic growth, few hyphae
2	microscopic growth, several colonies of hyphae
3	microscopic growth covers less than 50%, visible growth covers less than 10%. beginning spore formation
4	microscopic growth covers more than 50%, visible growth (mycelium) covers approx. 10-50%
5	strong growth in places, mycelium visibly covers more than 50%
6	very strong growth, mycelium covers almost 100%

Only from a mold index of 3 does the potentially problematic formation of spores begin. Values of up to '2' are therefore considered uncritical.



Course of the mold index in the second year (day 365-730) on the underside of the ceiling. A value of 0.1 is not exceeded, so there remains a large distance to the value of 3, from which spores can form.

System tests performed

DIN EN 1264	Test for room surface integrated heating & cooling systems with water flow to determine the heating/cooling capacity	MFPA Weimar
DIN EN 14037	Test for heating surfaces freely suspended from the ceiling with water flow for determination of heating capacity	WSPLab Stuttgart
DIN EN 14240	Test for cooling surfaces freely suspended from the ceiling with water flow to determine the cooling capacity	WSPLab Stuttgart
DIN 4102	Test for the classification of building materials according to their fire behavior into fire resistance classes	MFPA Leipzig
DIN 18948	Requirements, performance characteristics and test methods for factory-made clay building boards	MFPA Weimar
DIN 4726	Testing of oxygen tightness for pipes made of plastics	MPA Dortmund

Systempartner

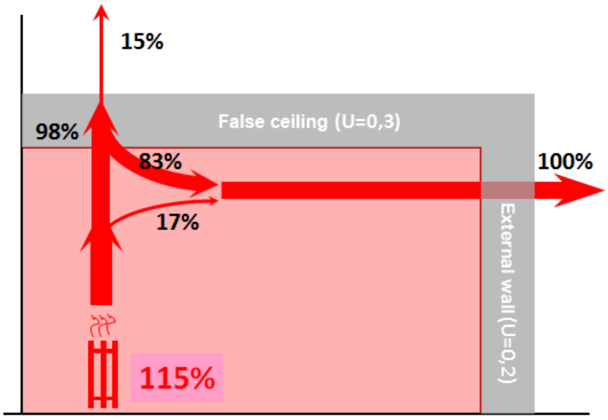
In order to be able to offer complete systems on the market, various cooperation agreements have been concluded with leading German manufacturers.

ArgillaTherm only uses system components that are subject to current standards and have been tested accordingly.

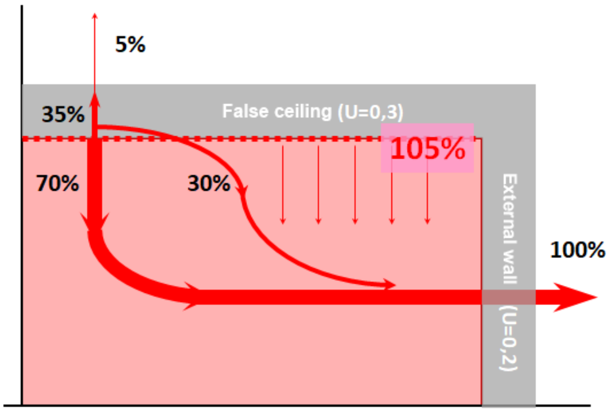
Firma Viega	Heating/cooling pipe	Special design
Firma Sorel	Control engineering	Standard products with specially stored control programs
Firma Spax	Fixings	Standard products
Firma Protektor	Ceiling suspension	Standard products, axle mass according to test statics
Firma Liaver	Acoustic system	Standard products

Sandwich construction for thermal and mechanical decoupling

Comparison; heating systems with a high proportion of convection / ceiling heating systems with direct connection to the masonry (usually wet systems) compared to the ceiling heating from ArgillaTherm



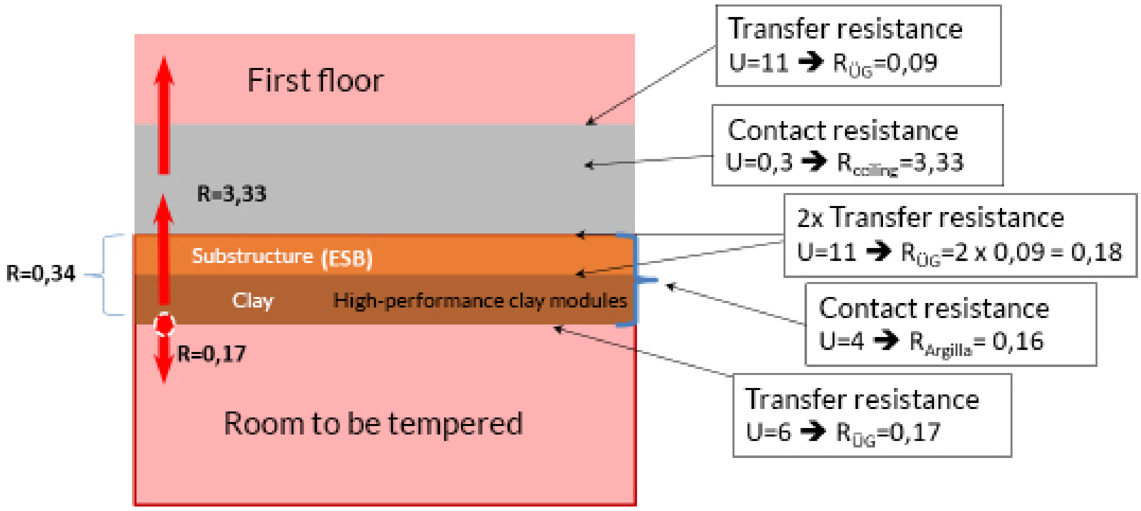
Heating systems with a high proportion convection or core activation



Ceiling heating from ArgillaTherm

The vagabonding heat on a typical winter day can be described by two parts: 1) The part that is stored in the false ceiling and 2) the part that escapes to the upper floor. Due to the sandwich construction, both proportions are significantly lower with ArgillaTherm's ceiling heating compared to heating systems with a high proportion of convection/ core activation.

Details about the thermal resistance due to the **sandwich construction** of the ArgillaTherm ceiling heating



The transfer resistance downwards is only about half of the total resistance upwards (transfer and contact resistances). Therefore about 2/3 of the heat goes directly into the room and 1/3 into the clay layer of the ArgillaTherm system building board. From there, a large part comes back again, because the resistance into the floor above is much higher than back into the clay panel.

The substructure of 22mm OSB/ESB boards is not required for solid wood ceilings!

Heating, Cooling, automatic humidity control, permanent room air cleaning and optionally via additional modules a pleasant acoustics with only one surface.

System flow temperatures

Depending on the heating power requirement, occupancy density and spread at

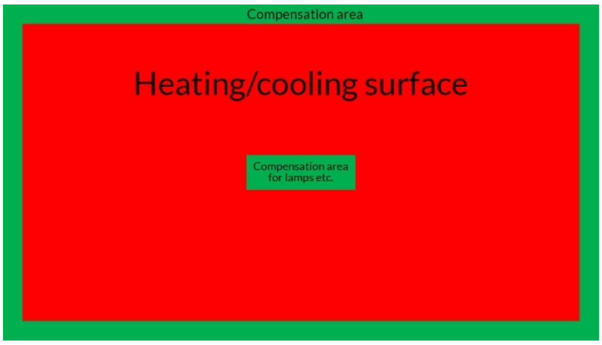
Heating: 25 – 45°C

Cooling: 8 – 22°C

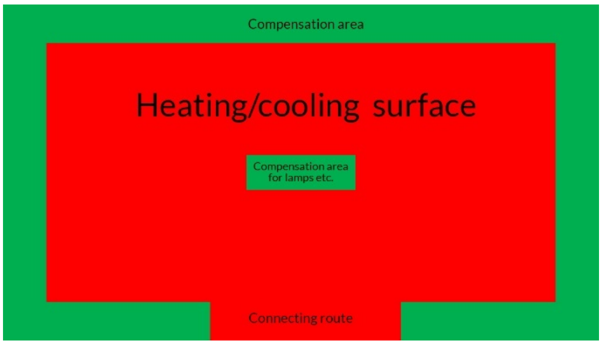
Reaction time / thermal inertia

Depending on the heating system, the response time is about 5-10 minutes, the high performance clay modules including clay plaster covering are completely tempered after about 60 minutes. If the energy supply is interrupted, the system keeps the surface temperature relatively constant for about 60 minutes, depending on the environment, due to the enormously high storage capacity of the high-performance clay modules. When heat pumps are used, interruptible heating current tariffs (heat pump tariffs) can therefore be used without buffer storage without any problems.

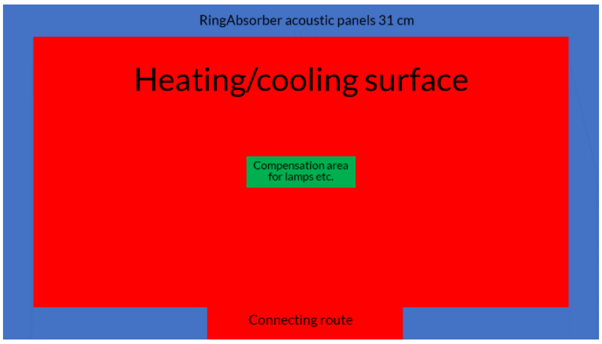
Variant ceiling heating/cooling with full surface coverage



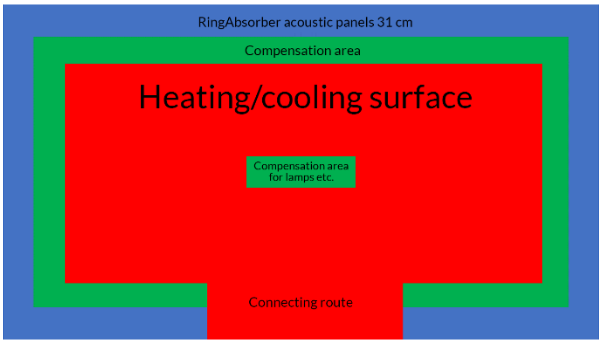
Maximum heating/cooling capacity



Reduced heating/cooling capacity

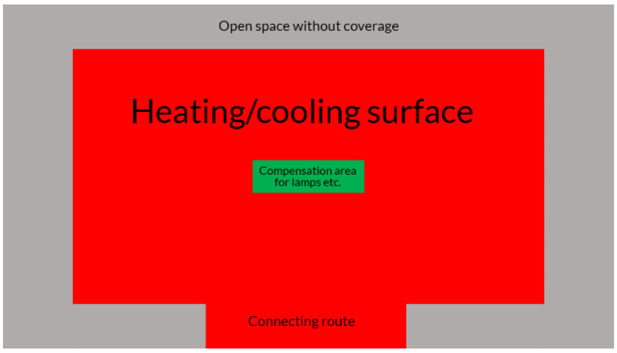


Maximum heating/cooling capacity with RingAbsorber acoustic panels

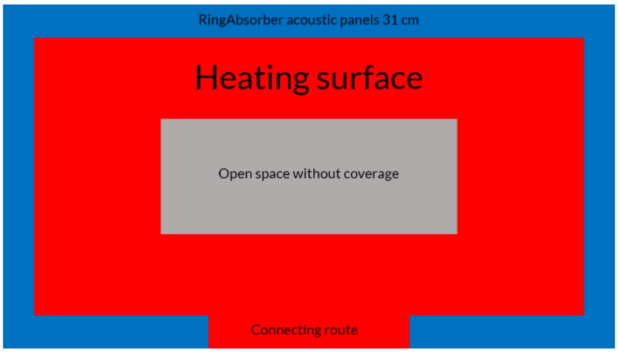


Reduced heating/cooling capacity with RingAbsorber acoustic panels

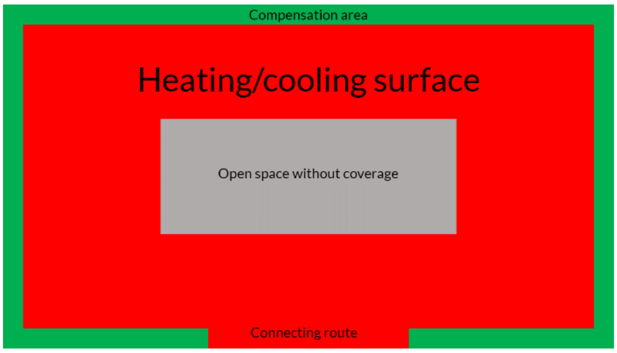
Variant ceiling heating/cooling with partial coverage



Interior partially covered ceiling without compensation area



External partially covered ceiling without compensation area with RingAbsorber acoustic panels



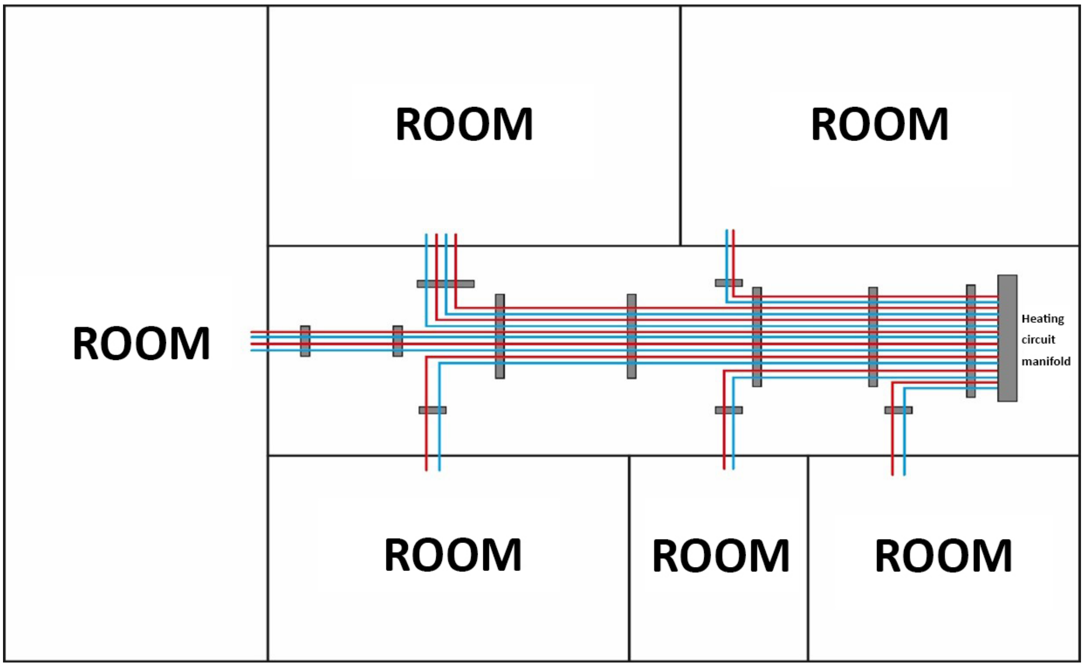
External partially covered ceiling without compensation area

Variant examples of partially covered ceiling without compensation area

External partially covered ceiling without compensation area

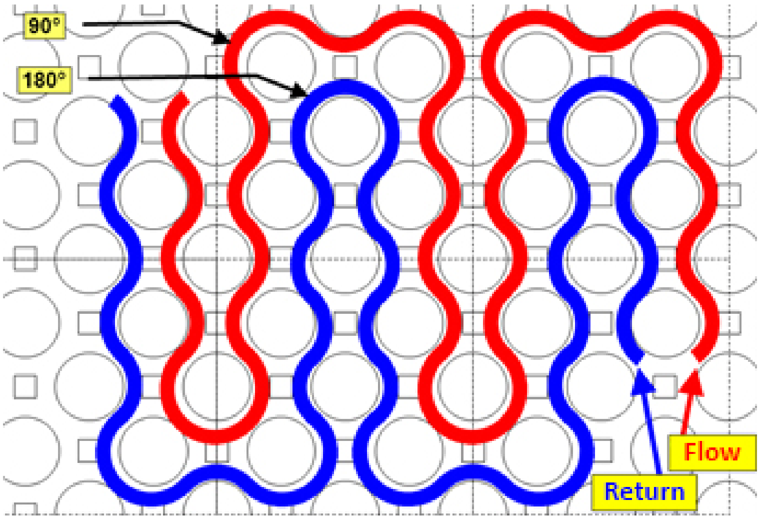
Internal partially covered ceiling without compensation area

Example of a connection at the heating circuit distributor/connection point



The corridor ceilings usually serve as a start-up route from the heating circuit manifold / connection point into the rooms to be tempered. The pipes are attached to the ceiling using suitable clamping rails / toothed rails and can be insulated on request.

Pipe laying in the High Performance Clay Modules



A module has 4 tracks for laying the cooling/heating pipe. The track 1 & 4 for the flow, the track 2 & 3 for the return.

Installation examples

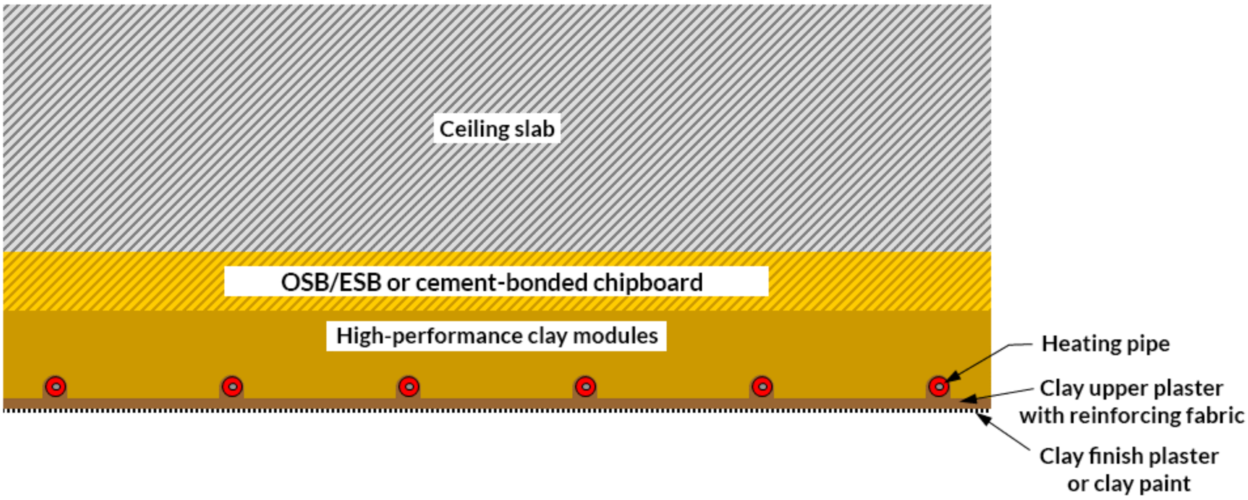
Fixing to substructure formwork with various ceiling outlets

Full-surface ceiling covering with high-performance clay modules and clay neutral panels

Connection surface with 13mm clay connection plate as plaster base

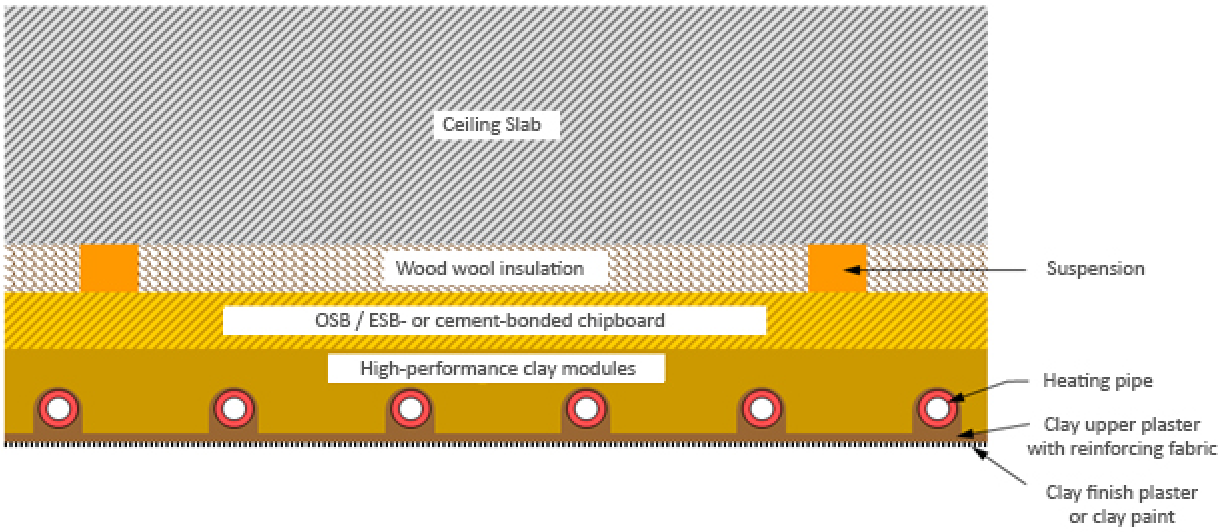
Mounting variants / system structure

Example 1:
direct fastening with OSB/ESB or cement-bonded chipboards
on the ceiling / installation height 52mm



The surface coating can be applied as described with clay plaster and clay paint, or with lime plaster and mineral paint. The decisive factor is the permeability of the covering material, so that the sorption capacity of the High Performance Clay Modules is not impaired. With solid wood ceilings, no chipboard is required; the modules can be fastened directly.

Example 2:
Fastening with substructure formwork, insulation if necessary and OSB/ESB or cement-bonded chipboard, construction height 52mm plus suspension

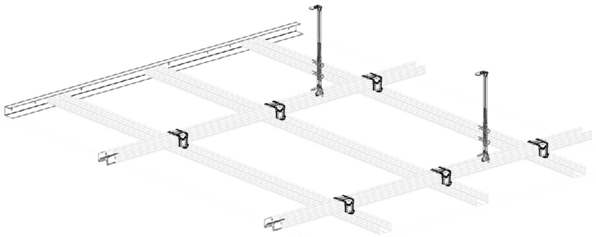


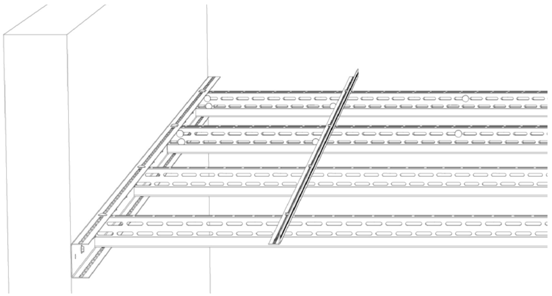
The surface coating can be applied as described with clay plaster and clay paint, or with lime plaster and mineral paint. The decisive factor is the permeability of the covering material, so that the sorption capacity of the High Performance Clay Modules is not significantly affected.

Example 3: Statically tested metal ceiling suspension in lightweight construction

a) with nonius connectors for ceiling mounting
75kg Load capacity (for UK from 22mm OSB/ESB boards)
Axial dimension CD basic profile = 600mm
Axial dimension CD support profile = 600mm
Distance Nonius-Pendant = 600mm
85kg Load capacity (for UK from 18mm CETRIS boards)
Axial dimension CD basic profile = 550mm
Axial dimension CD support profile = 550mm
Distance Nonius-Pendant = 550mm

b) self-supporting with wall mounting for significant reduction of impact sound





Technical planning and basics

When planning and designing ArgillaTherm® natural climate ceilings, the relevant regulations and standards must be taken into account.

DIN EN 12831	Method for calculating the standard heating load
DIN EN 1264	Room area integrated heating and cooling systems with water flow
DIN EN 14037	Determination of the heat output for suspended water-flow ceiling systems
DIN EN 14240	Determination of the cooling capacity for suspended water flow ceiling systems
DIN EN ISO 11855	Environmentally compatible building planning - planning, design, installation and control of surface-integrated radiant heating and cooling systems
DIN 16968	Polybutene (PB) pipes, general quality requirements
DIN 4726	Plastic pipelines, limit value for diffusion tightness
VDI 2035	Avoidance of damage in hot water heating systems
DIN EN 60730	Automatic electrical regulation and control devices
DIN 18947	Requirements for clay plaster mortar for plastering walls and ceilings
DIN 18948	Requirements, applications, performance characteristics and test methods for factory made clay building boards
DVL TM 06	Technical data sheet for clay thin-layer coatings of walls and ceilings

The work of the trades involved in the construction process must be coordinated accordingly.

Planning: Energy Consultant/Architect/Planner

Performing trades: Heating installer/drywall installer/construction company

Design of ceiling heating

The average surface temperature for ceiling systems with a height of up to 3 metres should not exceed 32°C according to the standard specification. With the wSYSTEM this value is achieved with a flow temperature of 38°C, the output is then 70 watt/m².

For ceiling heights above 3 meters, the average surface temperature can be higher and should be adjusted according to DIN EN ISO 7730.

The ceiling heating system is designed with a standard flow temperature of 35°C (corresponds to a capacity of 60 watt/m²), so that there is a reserve without compromising on comfort.

Lower heating outputs are achieved either by reducing the system temperatures or by reducing the surface area of high-performance clay modules while maintaining the same system temperatures. The remaining areas are covered with neutral panels.

Heat output ≙ Flow temp. - room temp. x factor 4 (tested according to DIN EN 14037)

With a flow temperature of 35°C, the average ceiling temperature is 2.5 K below the average value of the heating water. When the flow temperature increases, this value rises proportionally. The values that are important for the heating capacity output are listed in the following table.

Forward Temperature in°C	Return Temperature in °C	Ceiling Temperature in °C	Room Temperature in °C	Heating capacities Watt/m²
45,0	36,7	36,7	20	100
42,5	35,0	35,0	20	90
40,0	33,3	33,3	20	80
37,5	31,7	31,7	20	70
35,0	30,0	30,0	20	60
32,5	28,3	28,3	20	50
30,0	26,7	26,7	20	40
27,5	25,0	25,0	20	30

Flow temperatures and heating capacities for ceiling mounting

With regard to power output, the system was tested according to DIN EN 1264 and DIN EN 14037.

Self-heating effect of the high performance clay modules

The heat generated in the room during the day rises to the ceiling by convection (warm air). Heat sources can be e.g. people, electrical devices or incident solar energy. ArgillaTherm's highly compressed clay modules store this heat energy and the sandwich construction prevents the heat from migrating to the ceiling. If the room temperature falls below the temperature of the clay layer, the stored energy is released back into the room in the form of thermal radiation.

Design of ceiling cooling

The wSYSTEM is ideally suited for use in summer for room cooling by chilled water circulation in the piping, both in 2-pipe and 4-pipe operation with permanently changing system temperatures. The maximum heating circuit lengths and the mass flows should be designed the same for heating and cooling operation, with the reference variable in the design being the operation with the higher mass flow. This is usually the cooling mode.

The cooling capacity depends on the temperature difference (room minus supply). For example, with a room temperature of 26°C and a flow of 16°C, the cooling capacity is up to 65 W/m2. For other pairs of values, see the table below.

Forward Temp.	Room temperature 18 °C	Room temperature 20 °C	Room temperature 22 °C	Room temperature 24 °C	Room temperature 26 °C
10°C	52 Watt	65 Watt	78 Watt	91 Watt	104 Watt
12°C	39 Watt	52 Watt	65 Watt	78 Watt	91 Watt
14°C		39 Watt	52 Watt	65 Watt	78 Watt
16°C			39 Watt	52 Watt	65 Watt
18°C				39 Watt	52 Watt
20°C					39 Watt

Cooling capacity ≙ Room$_{\text{Temp.}}$ - Supply$_{\text{Temp.}}$ x factor 6.5

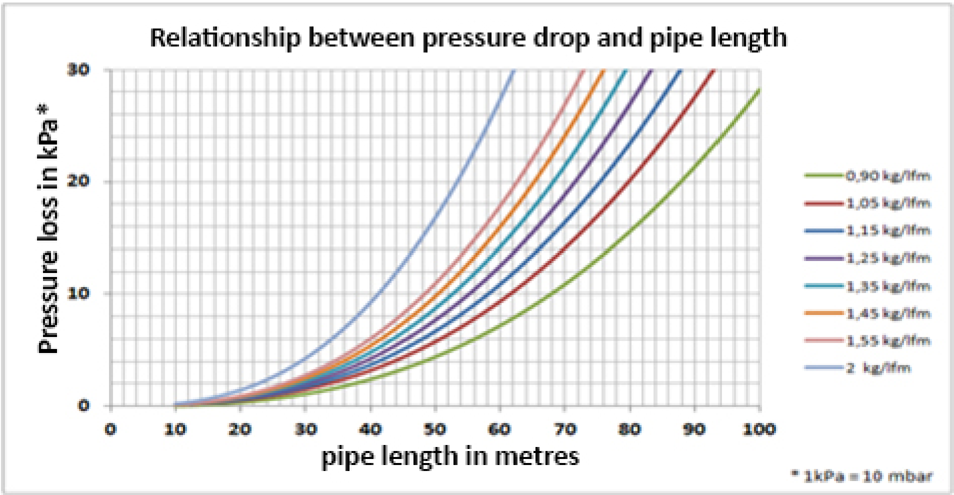
Regarding the performance data, the system was tested according to DIN EN 1264 & DIN EN 14240.

The system spread is dynamic, the RL temperatures can be determined as follows:

Example VL temperature 16°C, power 50W/m^2.

50W x 3600Jh = 180,000Jh ÷ 4,190J/kg/k = 42.96 ÷ 12.65 kg/h (11m x 1.15 kg/m pipe) ≙ 19.4°C RL temp.

The required mass flows and maximum desired pressure drops are indicators of the pipe lengths. In the following graph you can see all necessary data.



Areas of application

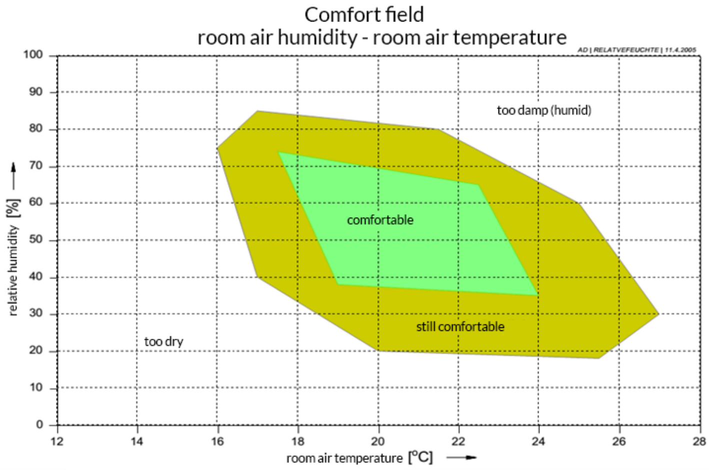
Due to the uniquely fast absorption behavior (A-value 1.6 kg/m²√h) and the large moisture storage, the system is particularly suitable for cooling buildings without mechanical dehumidification and in buildings with passive cooling by night ventilation.

- Ceiling cooling in buildings without mechanical dehumidification
- Ceiling cooling in buildings with mechanical dehumidification
- Ceiling cooling in buildings with passive cooling by night ventilation

Ceiling cooling in buildings without mechanical air dehumidification

At the heart of the system are patented high-performance clay modules. Due to the special composition with an increased proportion (about 6 times higher than classic building clay) of absorbent clay minerals, the natural increase in room humidity during cooling is counteracted and thus the comfort in the room (operative felt temperature) is significantly improved. A natural process that requires no control or monitoring technology!

Moisture storage capacity: > 500g/m² (for tested values see test report of MFPA-Weimar).



For each degree of temperature reduction, the room air humidity increases by approximately 6% of the initial value. If this value rises above 50 %, the natural "absorption instinct" of the clay minerals in the modules is activated and, as the room air humidity falls, the absorbed moisture is released back into the room.

In this way, the room temperature is lowered and the moisture content of the room air is kept constant without the use of mechanical air dehumidification.

The use of dew point monitoring or dew point control is recommended, but does not play a decisive role under normal conditions in our latitudes.

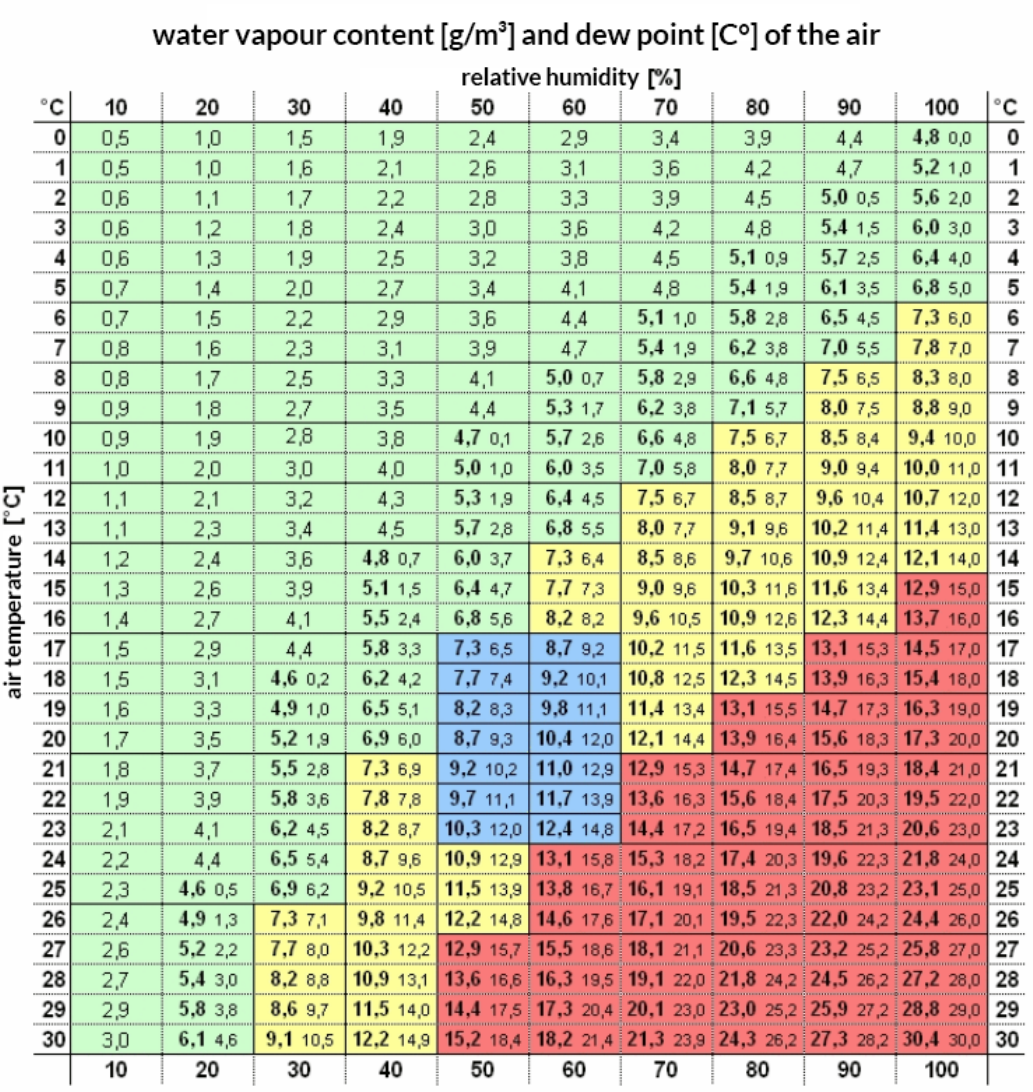
The active cooling phase should not exceed 12 hours per day. Thus, there is sufficient time for relaxation of the High Performance Clay Modules (release of the stored moisture) between the cooling phases.

If desired, a simulation of the moisture behavior in the room and in the masonry during cooling can be carried out (see page 4).

Ceiling cooling in buildings with mechanical air dehumidification

Buffering of moisture surges (e.g. at group meetings, during showering or cooking) due to the uniquely fast absorption behavior (A-value 1.6 kg/m²√h) and the large moisture reservoir (> 500g/m²). Punctual condensation water deposits due to uneven flushing of the room with pre-dried air are excluded.

An air exchange with a reference variable of 1000ppm CO² in the room and corresponding pre-drying of the supply air is sufficient for the removal of the accruing humidity and can be used <u>in all latitudes</u> (also under tropical conditions).



water vapour content [g/m³] and dew point [C°] of the air

relative humidity [%]

air temperature [°C]

°C	10	20	30	40	50	60	70	80	90	100	°C
0	0,5	1,0	1,5	1,9	2,4	2,9	3,4	3,9	4,4	**4,8** 0,0	0
1	0,5	1,0	1,6	2,1	2,6	3,1	3,6	4,2	4,7	**5,2** 1,0	1
2	0,6	1,1	1,7	2,2	2,8	3,3	3,9	4,5	**5,0** 0,5	**5,6** 2,0	2
3	0,6	1,2	1,8	2,4	3,0	3,6	4,2	4,8	**5,4** 1,5	**6,0** 3,0	3
4	0,6	1,3	1,9	2,5	3,2	3,8	4,5	**5,1** 0,9	**5,7** 2,5	**6,4** 4,0	4
5	0,7	1,4	2,0	2,7	3,4	4,1	4,8	**5,4** 1,9	**6,1** 3,5	**6,8** 5,0	5
6	0,7	1,5	2,2	2,9	3,6	4,4	**5,1** 1,0	**5,8** 2,8	**6,5** 4,5	**7,3** 6,0	6
7	0,8	1,6	2,3	3,1	3,9	4,7	**5,4** 1,9	**6,2** 3,8	**7,0** 5,5	**7,8** 7,0	7
8	0,8	1,7	2,5	3,3	4,1	**5,0** 0,7	**5,8** 2,9	**6,6** 4,8	**7,5** 6,5	**8,3** 8,0	8
9	0,9	1,8	2,7	3,5	4,4	**5,3** 1,7	**6,2** 3,8	**7,1** 5,7	**8,0** 7,5	**8,8** 9,0	9
10	0,9	1,9	2,8	3,8	**4,7** 0,1	**5,7** 2,6	**6,6** 4,8	**7,5** 6,7	**8,5** 8,4	**9,4** 10,0	10
11	1,0	2,0	3,0	4,0	**5,0** 1,0	**6,0** 3,5	**7,0** 5,8	**8,0** 7,7	**9,0** 9,4	**10,0** 11,0	11
12	1,1	2,1	3,2	4,3	**5,3** 1,9	**6,4** 4,5	**7,5** 6,7	**8,5** 8,7	**9,6** 10,4	**10,7** 12,0	12
13	1,1	2,3	3,4	4,5	**5,7** 2,8	**6,8** 5,5	**8,0** 7,7	**9,1** 9,6	**10,2** 11,4	**11,4** 13,0	13
14	1,2	2,4	3,6	**4,8** 0,7	**6,0** 3,7	**7,3** 6,4	**8,5** 8,6	**9,7** 10,6	**10,9** 12,4	**12,1** 14,0	14
15	1,3	2,6	3,9	**5,1** 1,5	**6,4** 4,7	**7,7** 7,3	**9,0** 9,6	**10,3** 11,6	**11,6** 13,4	**12,9** 15,0	15
16	1,4	2,7	4,1	**5,5** 2,4	**6,8** 5,6	**8,2** 8,2	**9,6** 10,5	**10,9** 12,6	**12,3** 14,4	**13,7** 16,0	16
17	1,5	2,9	4,4	**5,8** 3,3	**7,3** 6,5	**8,7** 9,2	**10,2** 11,5	**11,6** 13,5	**13,1** 15,3	**14,5** 17,0	17
18	1,5	3,1	**4,6** 0,2	**6,2** 4,2	**7,7** 7,4	**9,2** 10,1	**10,8** 12,5	**12,3** 14,5	**13,9** 16,3	**15,4** 18,0	18
19	1,6	3,3	**4,9** 1,0	**6,5** 5,1	**8,2** 8,3	**9,8** 11,1	**11,4** 13,4	**13,1** 15,5	**14,7** 17,3	**16,3** 19,0	19
20	1,7	3,5	**5,2** 1,9	**6,9** 6,0	**8,7** 9,3	**10,4** 12,0	**12,1** 14,4	**13,9** 16,4	**15,6** 18,3	**17,3** 20,0	20
21	1,8	3,7	**5,5** 2,8	**7,3** 6,9	**9,2** 10,2	**11,0** 12,9	**12,9** 15,3	**14,7** 17,4	**16,5** 19,3	**18,4** 21,0	21
22	1,9	3,9	**5,8** 3,6	**7,8** 7,8	**9,7** 11,1	**11,7** 13,9	**13,6** 16,3	**15,6** 18,4	**17,5** 20,3	**19,5** 22,0	22
23	2,1	4,1	**6,2** 4,5	**8,2** 8,7	**10,3** 12,0	**12,4** 14,8	**14,4** 17,2	**16,5** 19,4	**18,5** 21,3	**20,6** 23,0	23
24	2,2	4,4	**6,5** 5,4	**8,7** 9,6	**10,9** 12,9	**13,1** 15,8	**15,3** 18,2	**17,4** 20,3	**19,6** 22,3	**21,8** 24,0	24
25	2,3	**4,6** 0,5	**6,9** 6,2	**9,2** 10,5	**11,5** 13,9	**13,8** 16,7	**16,1** 19,1	**18,5** 21,3	**20,8** 23,2	**23,1** 25,0	25
26	2,4	**4,9** 1,3	**7,3** 7,1	**9,8** 11,4	**12,2** 14,8	**14,6** 17,6	**17,1** 20,1	**19,5** 22,3	**22,0** 24,2	**24,4** 26,0	26
27	2,6	**5,2** 2,2	**7,7** 8,0	**10,3** 12,2	**12,9** 15,7	**15,5** 18,6	**18,1** 21,1	**20,6** 23,3	**23,2** 25,2	**25,8** 27,0	27
28	2,7	**5,4** 3,0	**8,2** 8,8	**10,9** 13,1	**13,6** 16,6	**16,3** 19,5	**19,1** 22,0	**21,8** 24,2	**24,5** 26,2	**27,2** 28,0	28
29	2,9	**5,8** 3,8	**8,6** 9,7	**11,5** 14,0	**14,4** 17,5	**17,3** 20,4	**20,1** 23,0	**23,0** 25,2	**25,9** 27,2	**28,8** 29,0	29
30	3,0	**6,1** 4,6	**9,1** 10,5	**12,2** 14,9	**15,2** 18,4	**18,2** 21,4	**21,3** 23,9	**24,3** 26,2	**27,3** 28,2	**30,4** 30,0	30
	10	20	30	40	50	60	70	80	90	100	

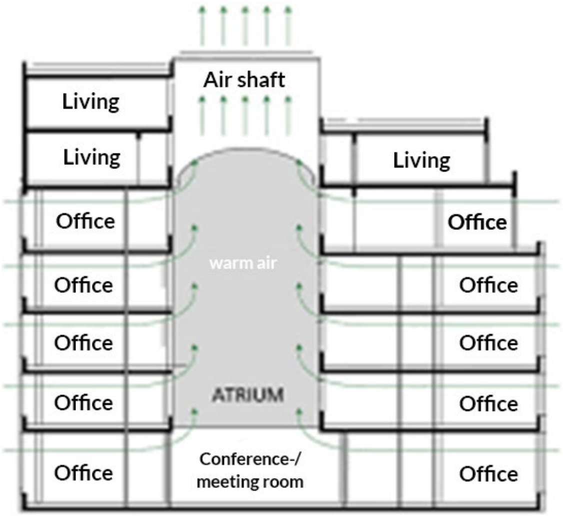
The natural climate ceilings can be used in buildings with mechanical pre-drying <u>in all latitudes</u> (including tropical conditions).

Ceiling cooling in buildings with passive cooling by night ventilation

By implementing the High Performance Clay modules with their uniquely fast absorption behavior (A-value 1.6 kg/m²√h) and large moisture reservoirs (> 500g/m²), the system is ideally suited for use in buildings with passive cooling through night ventilation. The operation mode is as follows:

Night: Charging the modules with cool moisture and convective release of the stored thermal energy from the day in the air flowing past.

Day: Release of stored moisture and absorption of room heat (mainly convective).



1g of moisture evaporation extracts the Natural climate ceiling 0.625 Wh thermal energy.
The release (evaporation) of 100 g/m² of moisture thus naturally generates 62.5 Wh/m² of evaporative cooling.

By charging the modules at night with moisture that is evaporated during the day, a noticeable cooling effect is created in the summer months.

The right building planning (cooling concept) is what counts!

- Boundary conditions of the site (climate, orientation, use)
- Building envelope (reduction of solar heat loads)
- Use (reduction of internal heat loads)
- Air shaft for using free night ventilation (chimney effect)
- Ensure transverse flow through the building

Regulation example circuit diagram

App-based with room-by-room control of temperature & humidity monitoring. The connection of the control units to each other is done with a suitable CAN bus cable. Plaster-in sensors are only required for static heating/cooling operation, i.e. at fixed system temperatures.

App-based with room-by-room control of temperature & humidity by integrating a mixer. 3-way, 4-way and 6-way mixers (4-wire technology) can be controlled. The connection of the control units among each other is done with a suitable CAN bus cable. Plaster-in sensors are only required for static heating/cooling operation, i.e. at fixed system temperatures.

Statics

Ceiling loads are calculated and designed according to DIN 1055. This specifies a load-bearing capacity of 1.5 or 2.0kN/m² for today's residential buildings. For older buildings with wooden beam ceilings, the load design is similar and is usually 1.5kN/m². 1kN corresponds to about 100kg.

Weight HighPerformance Clay Modules	**36,50 KG/m²**
Weight Clay neutral panels	**15,50 KG/m²**
Weight Fixing material, pipe and lime plaster without substructure	**13,00 KG/m²**
Weight Fixing material, pipe and clay plaster without substructure	**20,00 KG/m²**
Weight Fixing material, pipe and lime plaster and 22mm OSB/ESB board	**26,20 KG/m²**
Weight fixing material, pipe and clay plaster and 22mm OSB/ESB board	**33,20 KG/m²**
Weight Fixing material, pipe and lime plaster and 18mm cement bonded chipboard	**38,60 KG/m²**
Weight Fixing material, pipe and clay plaster and 18mm cement bonded chipboard	**45,60 KG/m²**

Example: 20m² of ceiling; 50% high-performance clay modules and 50% clay neutral panels

and a substructure of 22mm OSB boards, surface coating with lime plaster.

==> 10m² x 62,70KG (36,50KG + 26,20KG) and 10 x 41,70KG (15,50KG + 26,20KG) = 1.044 KG

==> 52,20KG/m² average weight

The maximum weight is 69.7 KG/m² (when fully covered with High Performance clay modules) and a surface coating of clay plaster.

Required materials per m² heating/cooling surface with surface coating lime plaster

OSB/ESB or cement-bonded chipboard with tongue and groove as substructure	1 m²
High-performance clay modules according to DIN 18948	7,23 Piece
Stainless steel – screw load distribution disc 5 x 50 mm & stainless steel - clamping screw 5 x 45mm	18 Piece
Polybutene pipe "Hot & Cool" according to DIN 16968, PB 12 x 1.3mm	11 m
Natural lime base plaster 66-20	14 kg
Glass silk mesh fabric, MW 7 x 7mm, 105g/m², 100cm wide	1 m²
Mineral paint as sprayable and brushable ready mixture (2 coats)	1 kg
Natural lime finish plaster 685-20 (optional)	*2 kg*

Required materials per m² heating/cooling surface with surface coating clay plaster

OSB/ESB or cement-bonded chipboard with tongue and groove as substructure	1 m²
High-performance clay modules according to DIN 18948	7,23 Piece
Stainless steel - screw load distribution disc 5 x 50 mm & stainless steel - clamping screw 5 x 45mm	18 Piece
Polybutene pipe "Hot & Cool" according to DIN 16968, PB 12 x 1.3mm	11 m
clay plaster „Thermo" according to DIN 18947	20 kg
Glass silk mesh fabric, MW 7 x 7mm, 105g/m², 100cm wide	1 m²
Clay paint according to DVL TM 06 as sprayable and brushable ready-mix (2 coats)	1 kg
High-grade clay plaster according to DVL TM 06 with 2mm application thickness (optional)	*3,5 kg*

Interfaces

1. Substructure	**Profession**
Protector metal ceiling suspension Mounting edge insulation strips and chipboard	Drywaller, construction company, carpentry
2. Heating/cooling technology level	**Profession**
Mounting HighPerformance Clay Modules and Clay neutral panels on the substructure	Heating installer usually with subcontract to drywaller, construction company, carpenter **or** drywaller, construction company, carpenter's shop
Lay PB pipe and connect heating circuits. Install ceiling sensor (optional)	Heating installer
Install room thermostat, connect ceiling sensor, connection to the servomotors by means of electric strip	Electrician
3. Surface coating	**Profession**
Filling the modules at panel level with clay or lime, fabric layer with clay or lime, finely grated (OF in Q2), ready for painting or, if desired, finish plaster with clay or lime (OF in Q3), clay or lime paint, 2 coats on fabric layer	Clay builder, plasterer, plasterer, drywaller, construction company, painter

Coatings and surfaces

Variants	**Filling of the high performance clay modules at panel level**	**Full surface plaster layer with fabric reinforcement**	**Surface finish**
Standard lime	**Natural lime HP 66-20**	**Natural lime HP 66-20**	**Clay roll plaster fine**
Lime 02	Natural lime HP 66-20	Natural lime HP 66-20	Mineral paint medium
Lime 03	Natural lime HP 66-20	Natural lime HP 66-20	Natural Lime Smooth HP 66-K
Lime 04	Natural lime HP 66-20	Natural lime HP 66-20	Natural Lime Smooth HP 66-K with clay paint
Standard clay	**Clay plaster Thermo**	**Clay plaster Thermo**	**Clay roll plaster fine**
Clay 02	Clay plaster Thermo	Clay plaster Thermo	Clay roll plaster coarse
Clay 03	Clay plaster Thermo	Clay plaster Thermo	Clay finishing plaster
Clay 04	Clay plaster Thermo	Clay plaster Thermo	Clay finishing plaster with clay paint

Connection to existing heating systems

1. **Control station with 3- or 4-way mixer and pump.**
   The flow temperature of the existing heating system is reduced to the desired flow temperature (approx. 35°C) of the ArgillaTherm ceiling system by means of a control station. The pump provides the necessary pressure and volume flow. The heating circuit lengths and volume flows are described in the points "Design ceiling heating" and "Design ceiling cooling".
2. **RTL control box with flow regulation in connection with the ArgillaTherm room thermostat**

   The remote sensor measures the ceiling temperature and transmits these values to the room thermostat. The room thermostat controls the actuator in the RTL box (product recommendation is the RTL-TH Basic combination box from Simplex, art. no. F11836), which is to be installed in the return flow. Since no additional pump is used here to transport the heating water, hydraulic balancing with the existing heating system must be carried out by adjusting the pressure differences.

   The following basic parameters must be applied:

   maximum heating circuit length = 60m, volume flow per hour = 0.9l per running meter of pipe laid

   Pressure difference in heating circuit = 80mbar