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Ceiling heating and cooling panels made of earth for a healthy room climate

A comfortable and pleasant indoor room climate is an important aspect in the design of any living or working environment. Climate control systems using earthen building materials makes it possible to positively influence the atmosphere of a room by regulating its thermal comfort. Gradual heating or cooling results in an indoor room climate that benefits the health and well-being of a room's inhabitants and promotes productive, concentrated work.

Ceiling mounted heating and cooling systems are therefore increasingly being installed in both domestic and commercial interiors. Alongside a desire for healthy climatic conditions, this is motivated by an increasing awareness of ecological considerations.

An indoor air temperature of between 20 and 22°C is considered ideal. Deviations from this can impact on personal productivity and well-being. For example, temperatures in excess of 26°C can affect our concentration span causing productivity lapses that in a work environment can be costly to a business. Efficient heating and cooling systems in combination with earthen materials are an ideal combination for creating a modern, ecological room climate.

According to German workplace guidelines, the optimum air humidity in offices should lie between 40 and 60% at a room temperature of around 20°C. In practice, however, this can fall below 20%, especially during intensive heating in the winter months.

01 WEM Headquarters: built in 2018, the energy efficient (KfW 55 standard) building features a photovoltaic plant, underfloor heating in the production hall and a climate panel ceiling and earth plaster in the office wing





02 The heating and cooling climate panels in the office ensure pleasant working conditions all year round



03 WEM climate panel ceiling made of earth for heating and cooling combined with Holz100 timber walling in the conference room.

It is here that earth building materials can contribute through their unique climate regulating properties.

Unlike conventional drywall materials, the heavier mass of earth building materials affords greater thermal comfort and has, in comparison, a better heating or cooling capacity than other commonly used building materials. In contrast to conventional air conditioning systems, radiant heating or cooling systems, whether installed in the walls or ceiling, operate noiselessly and without creating air flows and draughts. Earth building materials have a high drying capacity and can absorb small amounts of condensate when cooling and release it again as humidity levels change. The energy consumption of radiant

heating and cooling systems is also lower than air conditioning systems in which air must be heated or cooled. A radiant ceiling can be heated by various sources using a low temperature energy supply. For cooling, geothermal energy, ground collectors, wells, cisterns or other cold sources can be used. Regenerative energy sources are ideal for the operation of heating and cooling systems made of earth.

WEM's own climate panels are made of earth and also provide a long-term reduction in sound levels in buildings. A laboratory study undertaken at the University of Applied Sciences in Koblenz in a specially designed sound measuring chamber found that noise levels could be reduced by as much as 23.9 dB.

04 WEM climate panel ceiling after installation and joint filler at Dr Kauer vineyard



05 Interior of the wine tasting guestroom at Dr Kauer vineyard with the climate panel ceiling finished with earth plaster

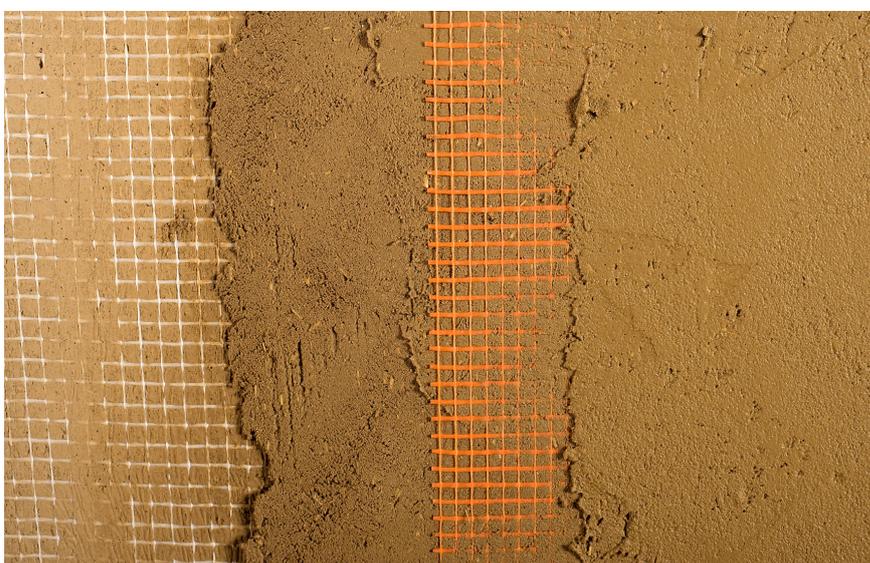




06 Pre-cut earth panels accommodate the pipe connections of the adjacent WEM climate panel to provide a flat, continuous surface for subsequent plastering



07 The climate panel elements are screwed to the suspended ceiling and the pipes linked together via compression-fitted connecting pieces



08 Typical plaster build-up on the climate panels: a base levelling coat of earth universal plaster, reinforcement mesh, and a fine earth finishing plaster



09 Modern house in north Italy (2012) – for summer cooling, the water for the climate panels passes through a ground collector



10 Ceiling-mounted WEM climate panels in a modern timber house in northern Italy (2005)

Climate panels made of earth are sustainable to produce and operate and thus contribute to climate protection. The use of earth building materials to regulate indoor climate opens up a previously unused sector for earth building with enormous potential.

While there are a wide variety of ceiling systems for heating and cooling on the market, WEM's climate panel system made of earth has a number of features that sets it apart. It can be installed quickly and easily and combines to form a continuous, even surface. Due to its shallow thickness of just 2.5 cm including the water pipes, it is particularly well suited for use in renovating existing buildings. After installation, the WEM climate panels – which can also be used to level uneven substrates – are given an approx. 5 mm thick coat of universal plaster followed by a 3 mm coat of dense earth finishing plaster. The climate panels are either screwed directly to the ceiling or mounted on a suspended supporting subconstruction.

The properties of earth as a building material are beneficial in both heating and cooling situations as its capacity to store moisture enables it to compensate for greater fluctuations than other building materials, significantly minimising the risk of condensation damage.

The purpose of regulating the indoor room climate is to create a thermally comfortable living and working interior that is pleasant to be in over extended periods of time. Comfort levels depend primarily on the following factors:

- Temperature of the room air and the enclosing surfaces (walls, ceilings, floors)
- Air movement
- Air humidity
- Air quality (pollutants, particles and odours)

There are two main physical principles used for heating and cooling interiors: convection or radiation.

Heating and cooling the room air (convection)

This principle employs air as the medium to supply or remove heat. The air is heated either by convection radiators or by one of the many types of mechanical air conditioning and ventilation systems using fans and heaters. Cooling is likewise provided by air conditioning systems: the air is cooled in a cooling unit and then supplied to the room interiors.

Heating and cooling room surfaces (radiation)

An alternative approach that is gaining increasing popularity is radiant room heating and cooling in which entire room surfaces emit or absorb warmth.

This principle is already well-known for providing heating in the form of wall heating or ceiling heating. Here the heat is emitted as thermal radiation, i.e. electromagnetic waves – the same principle that traditional tiled stoves employs, and indeed the sun.

Cooling also employs thermal radiation, but in the reverse direction. Excess heat from the human body or room radiates towards the cooler surface. Warmth is absorbed by the room surfaces and transmitted to

the embedded water-conducting heating and cooling pipes. The water transports the warmth away back to the heat exchanger, where it is cooled (the heat extracted) and then fed back into the system.

A major advantage of this form of heat transfer is that air flow is not required to convey heat, so that the indoor air need not circulate and remains largely motionless. Even small levels of air movement (upwards of 0.3 m/s) can produce draughts and a sense of discomfort among room inhabitants. In addition, moving air transports dust particles and dries out more rapidly. As a rule, the higher the radiant component of a heating system, the better the air quality.

Ceiling-mounted radiant heating has a high proportion of radiant warmth in excess of 90%. The convective component is very low because warm air, when present, collects beneath the ceiling and does not circulate from another radiator through the room.

Ceiling-mounted cooling employs this natural convective aspect: warm air rises towards the ceiling where it cools down, increasing the cooling capacity of the ceiling.

The advantage of earth as a building material

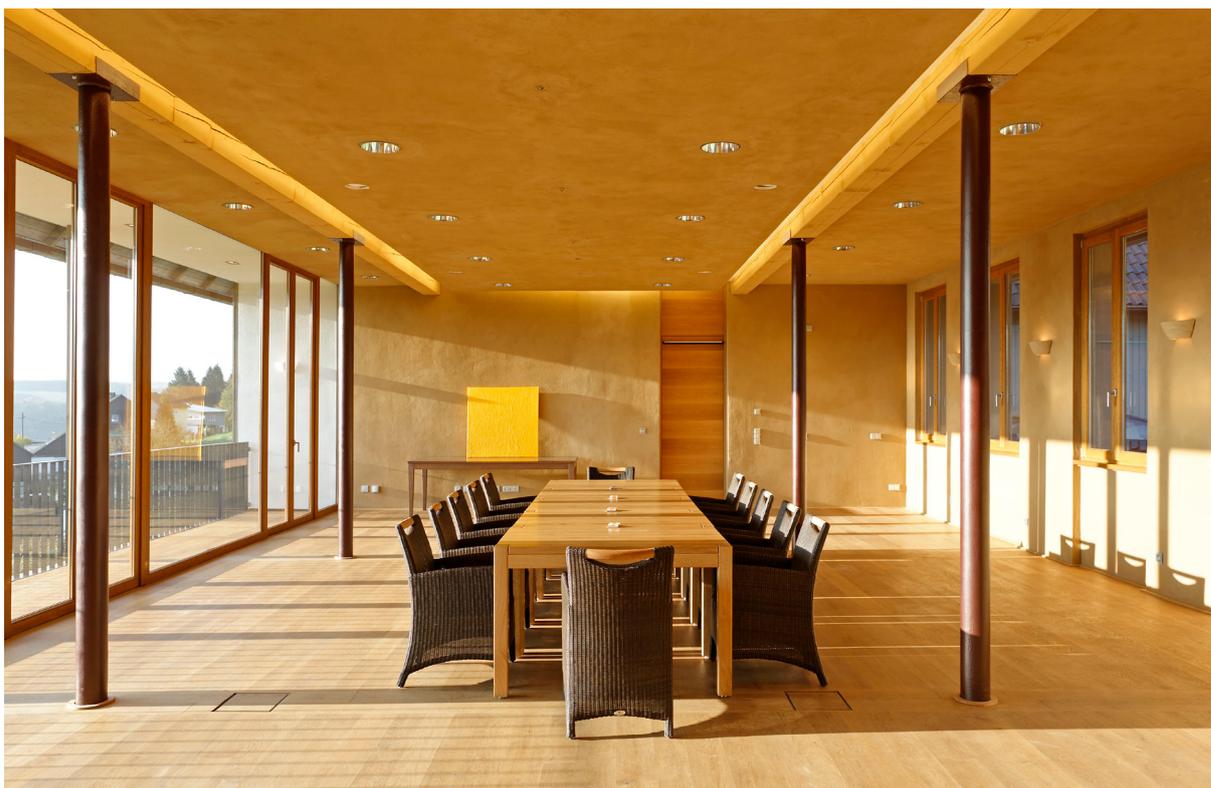
The particular qualities of earth mortar for distributing heat are well known and have been used for centuries to build stoves and ovens. Earth building materials have a high bulk density and thus good heat conductivity and heat retention properties.

“Of all the commonly used materials on the market, earth has the best heating and cooling performance per unit surface area.”

In addition, earth exhibits very good sorption characteristics, which means it can naturally regulate levels of humidity in a room interior. Short-term spikes in air humidity, e.g. water vapour from cooking or showering, are quickly absorbed by the earth building material. When the air humidity level drops, the wall returns the moisture to the room. The material balances the air humidity at a level of around 50%, which is optimal for human living and working conditions.

Earth is also good choice for ceiling-mounted cooling systems. The performance of ceiling cooling systems is always limited by the dew point temperature: if the temperature of the cooled surface drops too low for a specific air humidity level, water vapour in

11 Climate panel ceiling for heating and cooling in a conference room at EcoLut Lehmhaus in Engelskirchen, Germany



the air will condense on the surface, causing it to become wet.

“The sorption characteristics of earth building materials mean that they can absorb any condensation moisture that may arise (within limits) and then dry out again without leaving any residue.”

This is a major advantage over other materials: metallic surfaces cannot absorb any water and the condensate drips or runs off as soon as the droplets become heavy enough. Gypsum-based materials can absorb a degree of moisture but have less favourable drying characteristics: visible stains can remain and in extreme cases, plasterboard may even swell or become mouldy.

WEM climate panels made of earth actively regulate the indoor room climate, are safe in terms of the building physics and ecological to produce and operate. They provide an even surface and have a thin construction thickness. The panels come ready-made with integral embedded watertight and airtight heating and cooling pipes. The system includes all the necessary components such as connecting pieces, supplementary panels and technical fittings.

Surface heating and cooling in combination with earth building materials is becoming more and more established on the market. It is an ideal choice for all private homeowners and commercial clients who value the qualities of a healthy and sustainable indoor environment.

About the author

Gerd Meurer is managing director of WEM GmbH Surface Heating and Cooling Systems and a board member of the Dachverband Lehm e.V. (DVL), the German Earth Building Association. He is a publicly appointed and sworn expert assessor for earth building with more than 25 years of experience in the theory and practice of earth building, wall heating and interior insulation. He is also a trainer and examination assessor for the DVL “Specialist in Earth Building” vocational training programme held at the Centre for Restoration and Monument Preservation run by the Chamber of Crafts in Koblenz. In 1999 and in 2010 he received the Federal Prize for Excellence in the Preservation of Monuments in the Earth Building Trade.

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