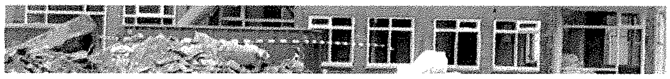

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Towards 0-impact buildings and environments

Transportation

Transportation to the venues and social activities are included in the fee. Busses are leaving from Boschstraat (nearby hotel Bastion) and Maastricht Central Station (nearby hotel Townhouse) on 10, 11, 12 and 13 October.

Posterinstructions
Instructions for a poster presentation:
The size of the poster board is 100 cm wide and 150 cm high.
The posters are supposed to be shown during all days of the congress. Please, try to be present, as much as possible, where your poster is situated, in particular during coffee breaks and lunch time in order to facilitate communication.

Programme at a glance

For a better printable and more detailed programme click here

SUNDAY, 10 OCTOBER 2010
14.00-17.00 First stone Eco/nnect ceremony at District of Tomorrow

17.00-18.30 Welcome Drink at the District of Tomorrow

MONDAY, 11 OCTOBER 2010
08.45-09.00 Opening of the conference

09.00-09.30 Welcome by the hosting organisations and government

09.30-10.15 John Kerkhoven: The energy transition model as a tool towards 0-impact

10.15-11.00 Rolf Disch: The Plus Energy House, an example of 0-energy

11.00-11.30 BREAK

11.30-12.30 Herman Scheer: 0-impact transition

12.30-13.30 Ronald Rovers: the concept of 0

13.30-14.30 Lunch and poster presentations

14.30-16.00 Concept Cafe 1: towards 0-impact materials
14.30-16.00 Paper session 1 towards 0-impact materials
14.30-16.00 Paper session 2 towards 0-impact materials

16.00-16.30 BREAK

16.30-17.00 Concept Café 2: towards 0-impact buildings
16.30-17.00 Paper session 3 towards 0-impact buildings
16.30-17.00 Paper session 4 towards 0-impact buildings

18.00-19.00 Travel to Heusden-Zolder

19.00-22.00 Sustainable Night in Heusden-Zolder

22.00-23.00 Travel to Maastricht

Organisation

In collaboration with

Partner(s)

Co-hosts

Sponsor(s)

TUESDAY, 12 OCTOBER 2010

08.30-09.30 Travel to Liege

09.30-09.45 Opening of the conference in Liege by Belgian partners

09.45-10.30 Alain Hubert: The Belgium Polar Station, an example towards 0-impact

10.30-11.00 Nils Larsson: Strategies for the 21st Century

11.00-11.30 BREAK

11.30-13.00 Concept Café 3: towards 0-impact sites
11.30-13.00 Paper session 5 towards 0-impact buildings
11.30-13.00 Paper session 6 towards 0-impact sites

13.00-14.00 Lunch and Poster Presentations

14.00-15.30 Concept Café 4: towards 0-impact cities
14.00-15.30 Paper session 7 towards 0-impact sites
14.00-15.30 Paper session 8 towards 0-impact cities

15.30-16.00 BREAK

16.00-17.30 Concept Café 5: towards 0-impact regions
16.00-17.30 Paper session 9 towards 0-impact cities
16.00-17.30 Paper session 10 towards 0-impact regions

17.30-18.00 Travel to location of boat at Liege

18.00-22.00 Dinner on boat from Liege to Maastricht

WEDNESDAY, 13 OCTOBER 2010

08.30-09.30 Travel to Aachen

09.30-09.45 Opening of the conference in Aachen

09.45-10.30 Thomas Rau: Oneplanet architecture

10.30-11.00 Hubert Rhomberg: The LifeCycle Tower as a new solution for urban architecture

11.00-11.30 BREAK

11.30-13.00 Concept Café 6: towards a 0-impact Euregion
11.30-13.00 Paper session 11 Design process tools
11.30-13.00 Paper session 12 Design process tools

13.00-14.00 Lunch and poster presentation

14.00-14.30 Christoph Maria Ravesloot: presentation of the Roadmap towards a 0-impact Euregion

14.30-15.30 Peter Vadasz, mayor of Güssing, Austria: 0-impact in reality

15.30-16.00 Mayors debate with the mayors of Heerlen, Maastricht, Liege, Hasselt, Aachen and Güssing.

16.00-16.30 Closing of the Conference

16.30-17.30 Farewell reception

17.30-18.30 Travel to Maastricht

THURSDAY, 14 OCTOBER 2010

8.30-17.00 Excursion through the three countries and site at: Solar institute Jullich, BOB building Germany, Solar project Genk, CeDuBo Heusden, Kamp C, Minewaterproject Heerlen, project Hundertwasser Valkenburg, District of Tomorrow.

District of Tomorro

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Learning environm

This conference is offered as a
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Thank you for your understan

Rehabilitation mortars for zero-impact buildings

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Abstract

The selection of construction materials represents a key step in any zero-impact building project. These materials account for several environmental impacts during their life cycle, and a significant part results from operational energy consumption. The need for new solutions, which improve the environmental performance without compromising the buildings interior comfort, has emerged. In recent years, new materials with innovative features have been developed. The rehabilitation market is an emerging sector and it is necessary to develop new materials suitable for this specific application but with higher performance. The application of sustainability principles in buildings rehabilitation improves conventional buildings, reducing their environmental impact. In this work, a mortar with latent heat storage capacity and proper for buildings renovation has been developed. The latent heat is stored in the finishing mortars and released later, reducing the operating time of building heating or cooling systems and helping to achieve the zero impact goal.

1. Introduction

The decision to demolish or recover old buildings in the cities historic centre is a frequently debated issue in the construction sector. In recent years, the most recurrent decision is to demolish, an option that allow to increase the urban density and build according to modern design standards. However, to raise new buildings implies higher materials consumption when compared to rehabilitation, where a large part of the structure and materials can be recovered. Recuperate old buildings minimizes new materials consumption and reduces the construction embodied energy. Demolition generates a wide amount of waste that needs to be transported, managed and treated properly, implying environmental and financial costs[1, 2]. Besides the economical and environmental consequences, it is important to consider the social benefits of building heritage rehabilitation. Old buildings restoration contributes to the nation cultural and historic preservation, stimulating the local economy. The construction industry consumes directly and indirectly a high amount of energy, that result from the materials embodied energy and the operational energy during building life cycle. The zero-impact goal can only be achieved with a zero-energy life cycle for both new and old buildings. Therefore, it is necessary that the rehabilitation process contribute to increase old buildings energy efficiency. A careful selection of building materials is a key step to achieve the zero-energy objective[3, 4]. In rehabilitation projects materials have to be compatible with the pre-existing products and structure, which limit considerably the available options. Since the rehabilitation market is gaining increasing interest, there is a demand for new materials able to improve refurbished buildings performance.

Many research efforts have been conducted in the past decades to increase energy efficiency in buildings, and the outcome was a number of technologies and solutions. Among them, the thermal energy storage (TES) is recognized as one of the most effective approaches for energy demand reduction in construction. There are three different approaches to successfully store thermal energy: sensible heat, latent heat and chemical heat storage. TES allows temperature to be temporarily stored for later use[5, 6].

Several studies have been conducted to develop construction materials with latent heat storage potencial[7-9]. PCM can be incorporated in mortars to provide them with energy saving capabilities. The PCM suitable for mortars incorporation is an organic type, consisting of a mixture of paraffin waxes encapsulated in a polymer. This organic PCM exhibits physical and chemical properties that allow it to store and release heat, contributing to maintain the indoor temperature in the comfort zone, reducing the building energy loads[10, 11].

Use of latent heat storage can be a practical and efficient mean of storing heat. Phase Change Materials (PCM) offer good density storage that results from the high latent heat of fusion at a constant temperature, known as phase transition temperature. When the temperature raise above the PCM phase transition an endothermic reaction occurs, the PCM turns from solid to liquid and the heat is stored. A temperature decrease causes the inverse change turning the liquid PCM to solid, an exothermic reaction, causing the heat to be released[7, 8].

This research work discusses the direct incorporation of a Phase Change Material in an aerial lime mortar. Aerial lime is the most suitable binder for many historic buildings repair mortars, exhibiting a good compatibility, high workability, good mechanical strength and water vapour permeability[12]. The thermal properties of a reference mix and several compositions containing different amounts of PCM were assessed. Some hardened state properties, such as mechanical strength, porosity and pore size distribution were also evaluated. This study aims to show that it is viable to prepare rehabilitation mortars able of latent heat storage that, combined with other passive design strategies, can reduce energy demand in zero-impact buildings[13].

The incorporation in construction materials and components can be done through direct incorporation, immersion or encapsulation. Phase Change Materials can be incorporated in passive building systems such as building blocks, walls, roofs, floors and ceilings. Alternatively, the PCM can be included in active heating and cooling systems [16-20]. Some research studies have been conducted on PCM incorporation in concrete mortars and gypsum plaster; however, there are no studies with this kind of rehabilitation mortars[17, 21, 22].

2. Experimental

The PCM selected for this work consists of polymethylmethacrylate (PMMA) microcapsules containing a mixture of paraffin waxes with a particle size distribution between 1.1 to 10.5 µm and average size of 6.2 µm. The transition phase temperature is 23 ° C and the specific heat 110 kJ/kg. Figure 1 represents a differential scanning calorimetry performed to the PCM The PCM exhibits a transition temperature of 25 °C in the heating cycle and 21 °C in the cooling cycle showing suitability for this specific application.

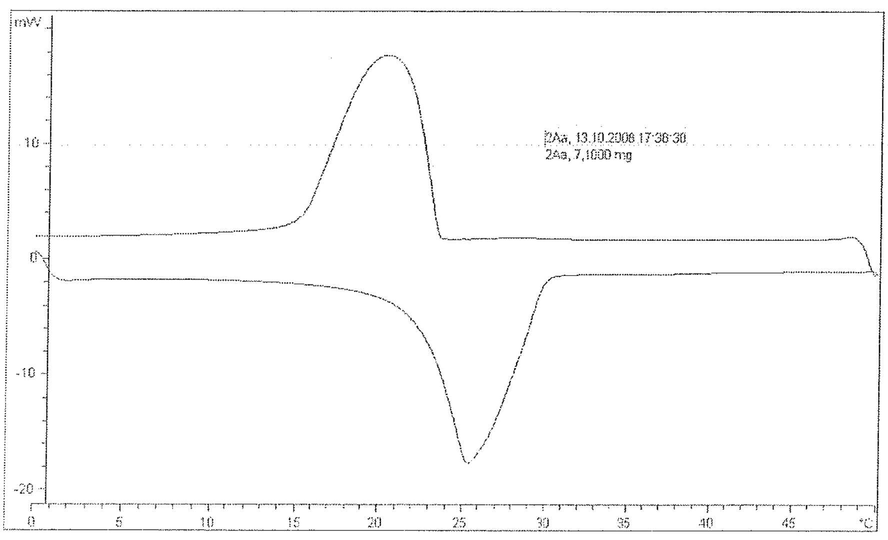

Figure 1 – Differential scanning calorimetry for the selected PCM

The mortars were prepared with a commercially available aerial lime, with a particle size distribution between 0.2 to 8.6 µm (particle average size 4.2 µm). The sand used as aggregate, has a particle size between 240 to 675 µm and a particle average size of 440 µm. The base mortar formulation has a 1:2 volume ratio of lime binder and sand. Different amounts of PCM (10, 20 and 30 wt.%.) were added to the reference mortar. The water content was set in order to guarantee the proper workability, measured by the flow table test.

The mechanical tests were performed after a 90 days curing period in a storage chamber at 20°C±2°C temperature and relative humidity of 65%±5%. For the mechanical strength tests, 3 samples were made for each composition, with 40x40x160 mm, according to the European Standard EN 1015-11.

3. Results and Discussion

3.1. Fresh and Hardened state properties

The water amount in these mortars varied between 24 and 33%, increasing with the PCM content. This was set according to the flow table test, maintaining the mortar spread diameter around 140 mm.

The addition of PCM to the mortars influences the mechanical strength as a result from changes in the internal pore size distribution. Figure 2 exhibits the mechanical strength evolution for the mortars compositions tested. The flexural and compression strength increases significantly with the addition of PCM. The spherical shape of the microcapsules and its average grain size contributes to better particle packing.

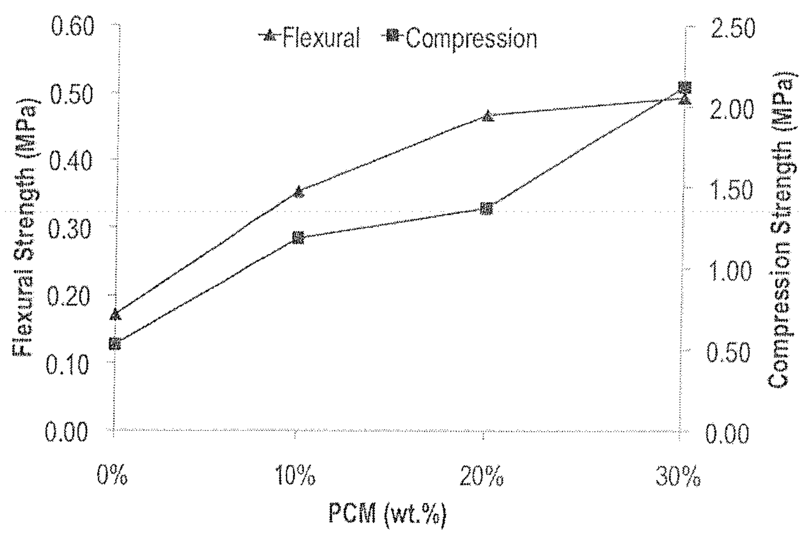

Figure 2 - Mechanical strength for the formulations tested

This effect is validated by the results obtained with the mercury porosimetry tests of mortar samples. The reference composition and the formulation with 30 wt.% of PCM were analysed (Fig. 3).

The total porosity for the reference mortar is around 30% with a medium pore size of 8.5 μm and the mortar incorporating 30 wt% PCM presents a porosity value around 33% with a 1.6 μm medium pore size. The effect of PCM incorporation reduces the larger and smaller size pores and although the slightly higher porosity, the average pore size is smaller, leading to a higher mechanical strength.

In Figure 4, microstructure analysis by scanning electron microscopy (SEM) of a mortar sample with 30 wt.% PCM allows to observe several microcapsules showing no evidence of capsule destruction or leakage.

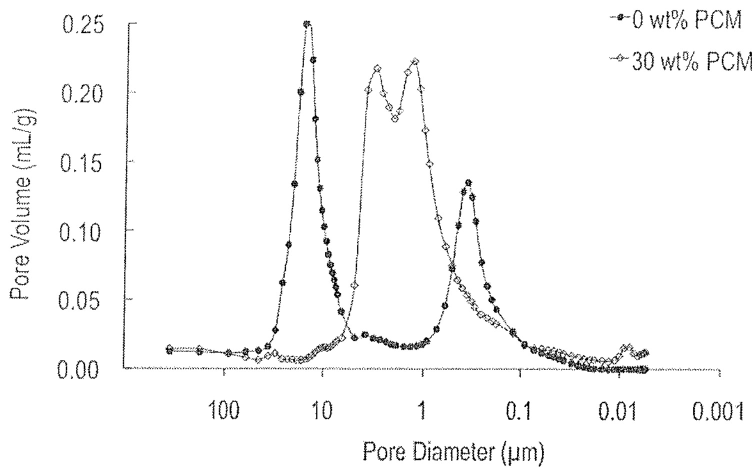

Figure 3 – Pore size distribution for the reference and 30 wt.% of PCM mortar

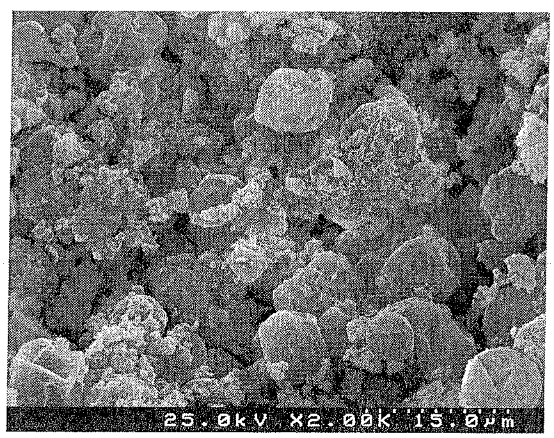

Figure 4 – Microstructure of a 30 wt.% PCM mortar sample (SEM)

3.2. Thermal performance of PCM mortars

To assess the impact of the PCM incorporation in the material a simulation test was performed in a climatic chamber[13]. A set of test cells, built with an insulating material was placed inside the chamber. The internal faces were covered with a mortar layer of approximately 100x100x3 mm (width x length x thickness). Each cell was setup with inside thermocouples connected to a data acquisition system, consisting of a data-logger with a multiplexer board connected to a computer that, using specific software, is able to record continuously all the temperature data (Fig. 5).

Different test boxes with mortars containing up to 30 wt.% of PCM and the reference mortar (no PCM) were subjected to heating and cooling cycles between 10°C and 40°C. These cycles intend to simulate the effect of night and day temperature variations.

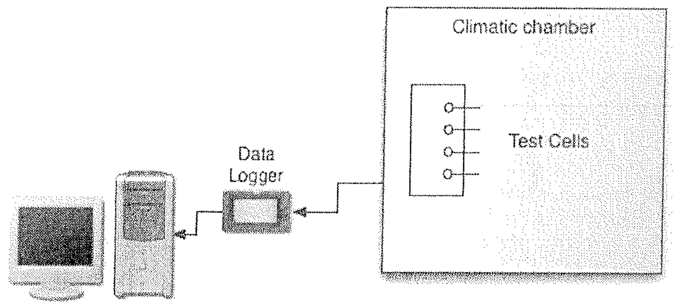

Figure 5 – Experimental set-up for the thermal tests

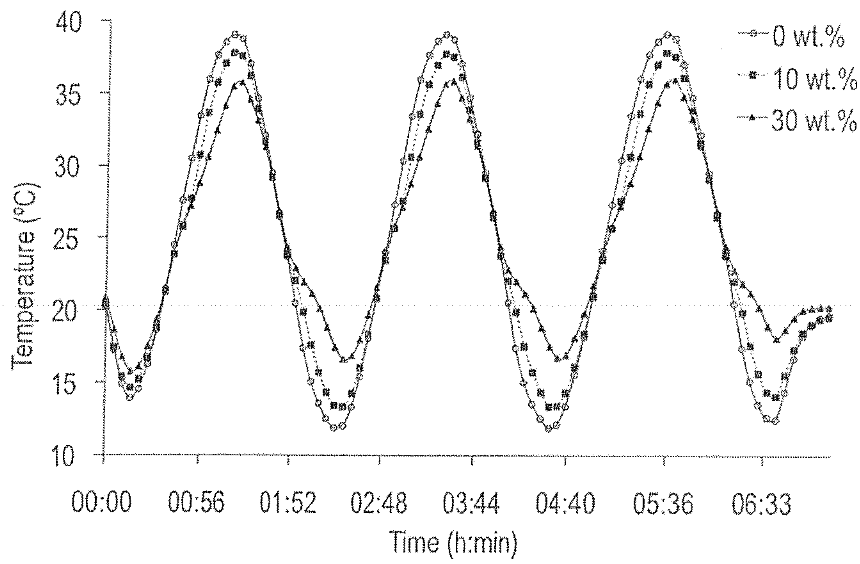

Figure 6 – Mortars thermal feedback to the test cycle

Figure 6 demonstrates that the presence of the PCM has a clear impact on the internal temperature of the cell. It is perceptible that the temperature increases less in the cell with 30 wt.% of PCM when the outside temperature rises to 40°C and, on the other hand, the temperature reduction is smaller when the outside temperature falls to 10°C. Moreover, the heating and cooling rate compared to the reference box is slower as the PCM amount increases leading to smaller temperature fluctuations.

4. Conclusions

The presence of PCM in rehabilitation aerial lime based mortars increase the mechanical strength and reduces the higher size pores in the hardened state, resulting in a better product performance and durability. Unlike cement and gypsum mortars, that exhibit a considerable loss in mechanical strength, these mortars reveal a performance improvement [11, 21, 23]. The microencapsulation has proven to be an efficient mean for PCM incorporation in mortars, since the capsules maintain their integrity even after the preparation and hardening process, thus contributing to the high thermal efficacy. The effect of the PCM amount on the thermal behaviour demonstrates that adding up to 30 wt.% results in a decrease of the heating and cooling rate on the samples tested.

The application of these mortars minimizes HVAC equipments operation time, reducing the energy demand in old buildings. The potential benefit of the Phase Change Materials (PCM) incorporation in aerial lime mortars, when combined with other energy saving strategies, is demonstrated.

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