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Energy Optimized Configuration of Concrete Element with PCM

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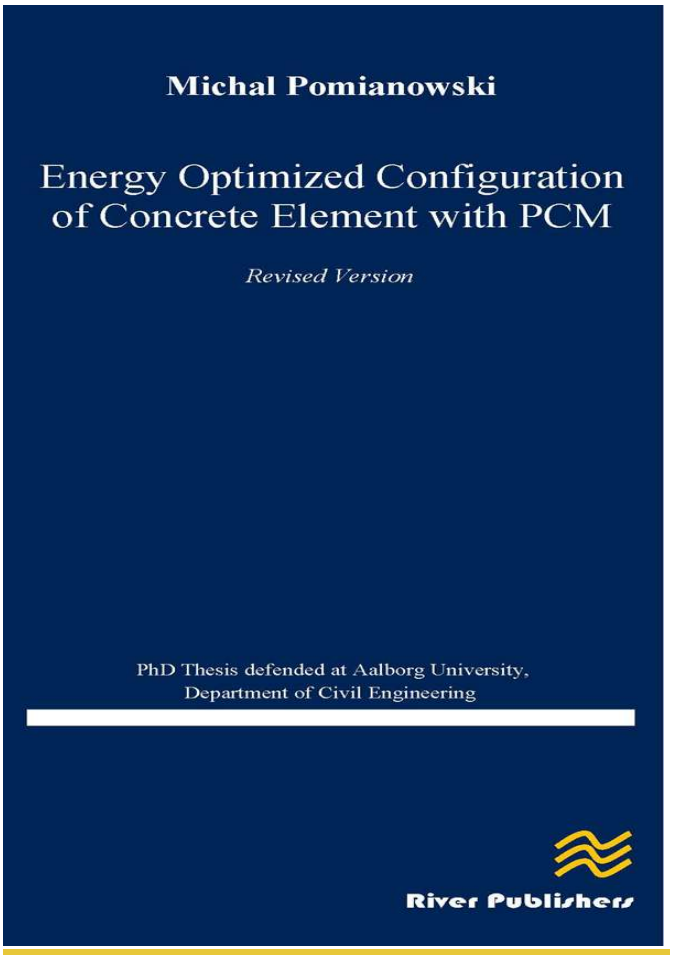
The building sector accounts for approximately 40% of the world's total use of primary energy, and the majority of this energy is used to maintain satisfactory indoor climate conditions by heating, cooling and ventilation.

Further on, traditional energy sources are irretrievably decreasing and the price of energy and fuel is gradually increasing. On top of that, the gas emissions to the atmosphere cause long-term and hazardous changes to the global climate. As a response to that, countries started to enforce new, more demanding legislations and standards for the newly constructed and renovated buildings. For example, in Denmark the new energy frames assume a reduction of primary energy use for buildings of respectively 25% in 2010, 50% in 2015 and 75% in 2020 compared to year 2006 figures. As a consequence, the building sector has to be equipped with the new technologies that would enable fulfillment of the new requirements regarding the new energy frames.

The concept presented and developed in the thesis focuses on the energy optimization and potential of the new product that could utilize the high thermal energy storage (TES) and thermally activated building system (TABS). The work investigates the potential of combining the microencapsulated phase change material (PCM) in the hollow core concrete deck element in order to increase the dynamic heat storage capacity of the internal envelope of the multi-storey buildings. Moreover, the study investigates the cooling capacity and performance of the concrete deck with PCM and integrated TABS and highlights limitations and challenges of the new technology.

Results from the full-scale investigation of dynamic heat storage capacity of decks indicated that there is no substantial difference between decks with extended heat transfer surface and one with an ordinary flat surface. Moreover, no significant improvement was observed for decks with PCM with regards to their reference deck cast with ordinary mortar. On the other hand, an improvement in the heat storage was observed for all deck casts with specially designed tiles on the bottom with regards to standard concrete deck element. These results, however, were unexpected since the material properties of mortar used to cast tiles were determined to be worse than those of concrete material used to cast standard decks.



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