Evaluation of alternative building materials for passive cooling to achieve thermal comfort and energy efficiency – A systematic review

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Introduction

Built environment is known as intense consumer of energy. Heating and cooling are the major functions that require multiple energy resources. In 2016-17, households accounted for about 24% of the total units of electricity consumed in India. The electricity consumption in residential sector has increased 7.93% that has grown at a rapid pace compared to other sectors during 2007-08 to 2016-17 (Energy statistics 2018). Several researchers have highlighted the shortcomings of the conventional building materials to address the energy consumption and enhance thermal efficiency in built environment. This highlights the need for innovation in the research and invention of alternative building materials that enables optimal thermal comfort in the built environment.

Alternative thermal efficient materials keep the building comfortable and reduce the load on mechanical air conditioning systems. Olgyay (1963) reports materials that reflect rather than absorb radiation and that more readily release the absorbed quantity as thermal radiation will cause lower temperature within the structure. He further adds that white materials may reflect 90 % or more, black material 15 % or less, of radiation received. Givoni (1976) points out that when the indoor thermal conditions are not controlled by mechanical means, the materials affect the temperatures of both the indoor air and surfaces and thus have a very pronounced effect on the occupant' comfort. Even when control is used, in the form of heating or air-conditioning for instance, the thermo physical properties of the materials used determine the amount of heating or cooling which is provided and also the temperature of the internal surfaces (radiant temperature). Therefore, even in these circumstances, the materials have an effect on the comfort of the occupants, as well as on the economic efficiency of the control systems.

The primary objective of the study is to investigate the performance of passive cooling building materials for thermal efficiency considering factors including thermal transmittance value, thermal mass, insulation properties etc. This paper is focusing particularly on the innovation done in the last few years in the field of passive cooling building materials. The emerging trends in passive cooling materials are aimed to achieve energy efficiency as well as to enhance the occupant's' comfort with respect to thermal environment. The research proposes to evaluate selected alternative building materials for passive cooling using Computer aided simulation models.

Materials and Methods

The flow chart below presents the proposed structure of the research. It involves five major stages. In stage 1 –Topic introduction describes the scope and purpose of the research topic which leads from a general research area into a refined topic for the study.

Stage 2, the literature review comprises a detailed literature study to understand the passive cooling building materials. The literature study will provide the fundamental knowledge for the research.

The next stage, consists of two phases. The first phase involves the collection of properties of selected thermal efficient materials. The second phase is a detailed computer simulated data on material evaluation incorporating thermal properties of materials. Stage 4 – deals with the analysis – In this stage, energy based software(s) will be used to analyse the thermal performance of materials in built environment.

The final stage (Stage 5) explains the findings and inferences from the findings. It will also discuss the relevance of the findings and direct towards the future research in this area.

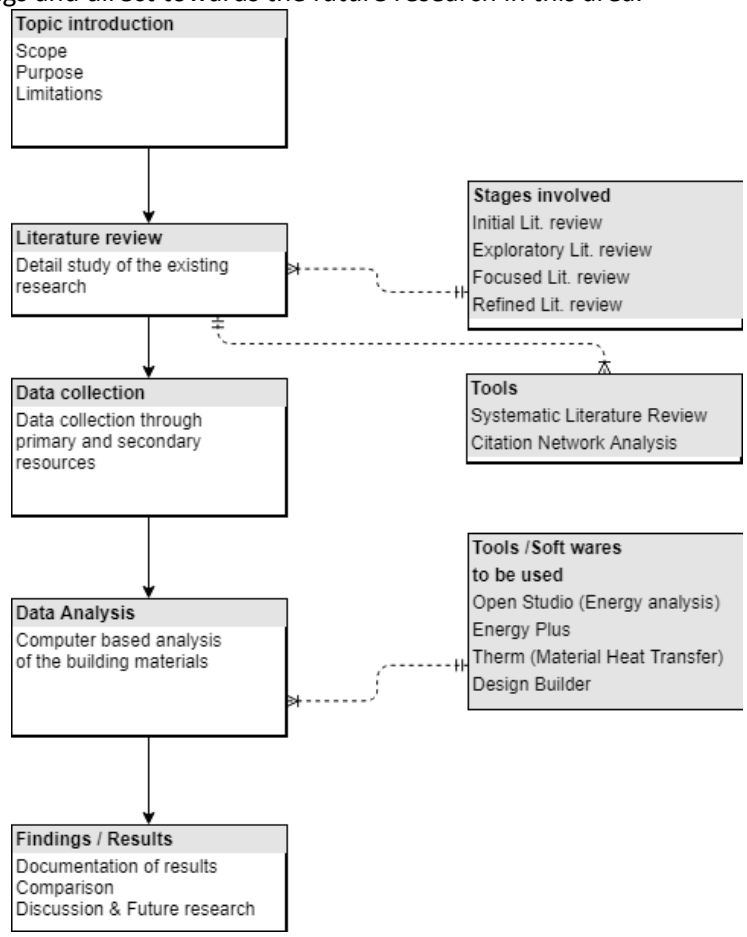

Figure 1. Research stages

Results and Concluding Remarks

Building materials have a significant role in reducing cooling and heating loads thereby achieving energy efficiency. The appropriate selection of building materials can reduce the energy load required on air conditioners. This paper is limited to evaluate building materials used to achieve thermal efficiency, other sustainable parameters are not been addressed. The quality of passive cooling materials in built environment is connected with several different aspects. The research also covers the factors to be considered for the selection of building materials which influence the energy requirements of building for heating and cooling load.

References

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