PERFORMANCE OF INSULATED ROOF SLABS ON BUILT ENVIRONMENTS IN TROPICAL CLIMATES

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ABSTRACT

The countries located close to the equator generally have tropical climatic conditions, where temperatures remain relatively high with humid conditions. Thus, the climatic conditions are usually identified as warm humid. With the rapid urbanization, two different solutions are adopted to meet the housing needs. One is the construction of medium to high rise apartment buildings which has become popular in many large cities located closed to the equator. Another option have been to pursue residential developments with a large number of detached houses located on small blocks of lands.

The energy consumption for buildings is becoming higher and high energy demand and the associated green house gas emission is another critical issue that needs attention in the long run. Global warming can also become a key factor in near future due to environment and climatic changes that are associated with it. This emphasise the need to develop and promote new passive techniques to achieve thermal comfort in built environment. The use of insulated roof slabs provide an alternative that may enable the creation of green cover at roof level. This can also become an alternative solution to the traditional roofs since insulation can be effective in creating desirable indoor conditions needed by free running spaces and the flat slab on top of the building can solve many environmental and social problems arising out of high density residential developments to a certain extent. In addition, this can be an ideal alternative to traditional roofs considering the better cyclone resistance that can be offered due to the self weight.

Considering all these facts, reinforce concrete solid slabs were considered as an alternative. With detailed experimental programmes on small scale models and prototypes, it is shown that a minimum insulation thickness of 25 mm with a material having a conductivity of about 0.03 W/mK can retard the heat flow significantly. In order to ensure that roof slabs have unrestricted access, an innovative solution was proposed and used as the insulation system for the experimental programme. Since it is practically difficult to predict the effect of insulated roof slabs on built environments such as houses using actual model based experiments, simulations have been used with computer software validated for tropical climatic conditions to predict the trends. Since there are strong indications of changing climatic patterns due to global warming, the performance of insulated roof slabs under such future scenarios have also been predicted using appropriately modified climatic files.

In order to emphasise the need to rely on carefully planned micro climate in future, thermal comfort models have been developed considering the climatic acclimatization that is expected from people gradually facing the global warming scenarios over a long period of time. With all these studies, it is highlighted the importance of adopting insulated roof slabs as a solution to combat the heat island effect in built up areas by creating roof top gardens. Since these slabs can be successfully adopted in air-conditioned commercial buildings, life cycle costing approach was used to predict the desirable insulation thickness for air conditioned spaces. With this multi-disciplinary approach, the usefulness of insulated roof slabs as an alternative to traditional roofs have been highlighted.

Key words: Tropical climates, flat roof, heat island effect, global warming, thermal comfort, roof insulation, computer simulation, life cycle cost.

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DECLARATION

I, Rangika Umesh Halwatura, hereby declare that the content of this thesis is the output of the original research work carried out over a period of 45 months at the Department of Civil Engineering , University of Moratuwa. Whenever any work by others is included in this thesis, it is appropriately indicated as a reference.

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