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A SIMULATION STUDY OF THERMAL COMFORT IN EARTH FORMED SPACES

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A Dissertation

Submitted to the Department of Architecture

 Of the University of Moratuwa
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In partial fulfilment of the requirements

For the degree of

Master of Science

In

Architecture

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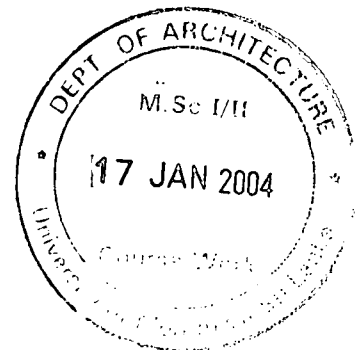


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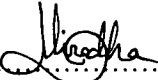


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DECLARATION

I declare that this dissertation represents my own work, except where due acknowledgement is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualification.

Signed:.....

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ACKNOWLEDGEMENTS

It is with sense of deep gratitude I place on record my sincere thanks for the inspiring and able guidance, which was available for the very inception of this work. I would like to make special mention of Architect Vidura Sri Nammuni, Head of the Department of Architecture, Architect Prasanna Kulathilaka, Dr. M.R. Emanuel, and senior lecturers, Faculty of Architecture, University of Moratuwa for valuable and indispensable guidance in formation of the study.

Most respectfully, I wish to state that my task had been extremely difficult if not for the guidance, advice and help given to me in numerous ways by the followings.



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K.M. Pradeep

S.T.N.J.Jayawardana

D.S.Ranasingha

And members of own family

D.M.N.I. Gunadasa

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A SIMULATION STUDY OF THERMAL COMFORT IN EARTH FORMED SPACES

ABSTRACT

This is a continuation of the B.Sc. dissertation of the writer, which concludes that rocks can moderate the level of thermal comfort inside the spaces they form. It is likely that over other material, rocks have potential to create thermally comfortable spaces in the context of Sri Lanka.

This Dissertation has expanded the range of study from rocks to earth architecture. This begins with the identification of the thermal sensation as an integral part of spatial experience and therefore as a feature of the spatial art. Integration of earth is seen as the possible mode to create and orchestrate thermal moods in Architecture.

This deals more with the identification of the underlying principles behind the thermal behaviour of earth material and the use of them as tools of Architecture. The study is based on computer simulation of the thermal behaviour of earth formed spaces, which enables an otherwise impossible multiplicity of flexibilities, options, control over variables and accuracy of testing and comparison.

The study identifies the need to integrate boulders and heaps of material, instead of walls and roofs, and discusses the need to rethink of spatial articulation beyond the conventions.



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INTRODUCTION

A Simulation Study of Thermal Comfort in Earth Formed Spaces

A SIMULATION STUDY OF THERMAL COMFORT IN EARTH FORMED SPACES

INTRODUCTION

1.1 Thermal sensation is an Integral part of spatial experience

Architecture embeds mindsets in spaces. The Architectural space may project unto you a sense of loneliness, a sense of relief, or a sense of an unknown sorrow by creation of a setting that craves out bygone pains buried in bygone memories. Alternatively, it may create a setting that makes you forget all your pains and generate relief and mindfulness. Or, perhaps, do both at the same time that creates a nostalgic bitter-sweet moment. Thereby, Architecture becomes a concretization of frames of mind. It freezes moods into volumes and forms of space and makes the spatial experience something beyond the mere perception of space. Experience of space becomes experiencing a work of art.



Music is the art of those heard, painting – those viewed and Architecture is the art of those lived! Like in all arts, in Architecture too the carnal satisfaction of leads to the intellectual joy. However, the spatial experience is not a proliferation of stimuli of one sense but consist all those heard, viewed, felt and understood. The sense of space that generates spatial experience is multi faceted.

Space being experienced with all senses, the thermal sensation comes to be an integral part of it. In the visits, we have made to rock formed places such as Polonthalawa Farmhouse and Vessagiriya Caves, it is felt that despite the awe-inspiring grace and calmness of rocks, the thing that enchants us to the place is the felt little chill of atmosphere. Together with other sensory experiences, the thermal sensation takes part in bringing out frames of mind of serenity.

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1.2 Scope of the study

However, it is said, virtually, that it is impossible to achieve a comfortable thermal environment in our climate with passive means. This brings the debate that how one can think of thermal orchestrations when it is impossible to achieve at least the comfort range in tropical climate.

It is seen that this thermal discomfort of our environment is due to the nature of material and concepts of development of the modern day. There is no argument that there was one time where the streets are shaded with trees and people were comfortable in the wattle built houses. The earth, as a building material, seems to have played a vital role to create thermally comfortable spaces. It is important to study the possibility to achieve the same but in terms of modern technology and needs. However, the vista of this study is beyond the study of wattle built walls but rests upon the integration and articulation of rocks and heaps of earth as themselves.



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1.3 Justification to integration of earth to Architecture

Justification for thermal comfort in architecture.

In tropical buildings, the thermal sensation seems to be almost taken too loosely as if it is assumed that the only thing to achieve in the aspect of thermal experience is the standard thermal comfort level and nothing else that we do not see orchestrations of thermal sensations in buildings.

Much is thought about the visual sensation of a space in their act of creation but the submerged use of other sensory stimuli is weakening. As a result, instead of being an art of weavers that weaves together several sensory images to stage a dramatic scenario of space, Architecture has become unilateral and 'monochrome'.

This may be because there is no spur to visualise space in terms of olfactory and tactile senses. Nevertheless, the thermal sensation is a direct outcome of form and material and can be visualised in terms of Architecture. Therefore, the need to investigate the ability to use thermal sensation as a gizmo of mood creation is felt as imperative.

1.4 Previous findings - earth as a moderator of thermal sensation

The history of Architecture and Social Studies essay of B.Sc. (B.E.) of the writer is concluded with the statement that rocks and earth do moderate the level of thermal comfort inside the spaces they form. They moderate the average temperature (average of the temperature measured for 24 hrs) inside the space in relation to that of the outside and they effect the heat flow due to time lag effect.

Behaviour of earth material differs from that of conventional insulators. In case of rocks and earth material, Thermal Diffusivity and Heat Capacity of the material become the governing factors of heat flow. Thermal Conductivity is less important. Theoretically, the thickness of a rock shell required to bring the level of thermal comfort to an appropriate value in Sri Lanka is approximately 0.5m.

There is nothing more to prove on the fact that earth and rock can moderate the level of thermal comfort felt inside the spaces they form. What is to be found out is the integration of it in Architecture.

1.5 Towards a study of Earth Architecture

The important aspect here is that earth formed spaces can orchestrate thermal sensation due to the flexibility of the thickness and possibility to use as bulks, which the standard brick walls or standard concrete slabs by no way can do.

It is no wonder that the integration of earth material to Architecture, due to their physical properties, has to be in the form of boulders and mounts. This will affect all key constituents of Architecture – the form, the space and the details. What the articulation of earth going to challenge are not only the thermal properties of spaces but also the very roots of the conventions of spatial articulation. The spatial ambience, the ways of encapsulating the space, the detailing of it, all will be radically challenged. It is an invitation to break through these mind-forged manacles and rethink of the form of space and the spatial articulation not in terms of walls, floors and roofs but in terms of space itself.



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On the other hand, the feeling of space and the meaning of space will be stronger due to the articulation of earth. Though it can be argued that Architecture has the potential to affect ones psyche, whether those contemporary buildings with alien forms and material can do it, is a problem. When we talk about whispering to ones inner self by the means of forms and spaces, those forms and spaces should some how be meaningful to his intellect.

Rocks and earth are elements closely related to human life from the beginning of human civilization. Their effect on formation of human cognition – in the formation of the concept of home (rock caves), beliefs, religion and feelings of awe and respect is enormous. Earth is the true womb of man. Therefore looking at a rock, one can perceive things beyond its physical

existence – rocks and boulders of earth have instinctive meanings. There is the possibility to use them as strong Architectural proliferators that evoke instinctive references once laid deep in human mind.

Therefore, a challenging architectural problem is observed in integrating earth to Architecture. However, this study is not going to touch on the broader aspect of the human instincts embedded in earth forms but narrow it down to the thermal sensation of the earth formed spaces and use of it as a tool of mood creation. When it comes to the practical application of the integration of identified principles, the problem of articulation of rocks and boulders too is to be discussed.

1.6 Method of study

Mechanical properties of earth and behaviour of earth material is identified with a survey of literature on the subject. The existing kind of earth Architecture that is evolved with the development of human civilization is studied. Thereby, in both the aspects the resultant nature of earth Architecture is rendered.

Thermal performance of earth material and principles behind the phenomena are revealed with simulation studies. The integration of the identified principles to the identified nature of earth Architecture is discussed and thereby concepts are derived for the practice of thermal comfort conscious earth formed Architecture.

The possibility to use the concepts to manifest moods of space and orchestrations of thermal sensation is discussed. The thinking process to be followed by the designers of 'earth' is discussed.