

# A STUDY OF STRATEGIES FOR ENERGY EFFICIENT ENVELOPE DESIGNING FOR RESIDENTIAL BUILDINGS IN SRI LANKA

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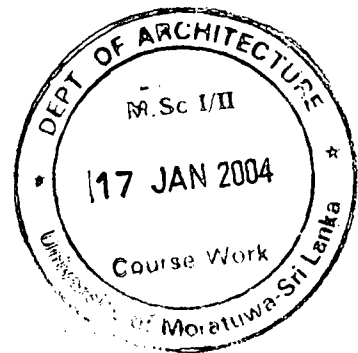
University of Moratuwa Sri Lanka, as a Partial

Fulfillment of the Requirement for the

Degree of Master of Science in

Architecture.

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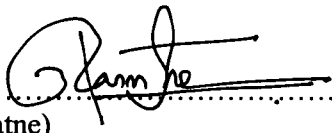
**ROSHAN KARUNARATNE**  
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## DECLARATION

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.

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# **ACKNOWLEDGEMENT**

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# ACKNOWLEDGEMENT.

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# ABBREVIATION

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# ABSTRACT

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## **ABBREVIATION**

**OTTV** : **Overall Thermal Transfer Value ( $W/m^2$ )**

**CEB** : **Ceylon Electricity Board**



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ABSTRACT

## ABSTRACT.

Being scarce resources energy conservation is becoming an important issue today. It behoves that the new energy conservation strategies, regulations considerably contribute to solve the problem.

Energy efficient building code (EEBC) for Commercial buildings (Published by Ceylon Electricity Board) has got certain guidelines / regulations to achieve energy saving of the Commercial sector buildings. However yet there is no such rule or code to guide or investigate the domestic energy usage. At the same time electricity consumption in residential sector in Sri Lanka is almost significant percentage of the total electricity supply. Also total electricity demand of the country increasing approximately 10% annually. Hence Energy efficiency achieved through building designing is important.

For this matter it attempts to examine the energy efficient envelope designing. Therefore several residential houses were examined and analyzed in terms of architectural portion of (overall thermal transfer values) electricity usage and OTTV of them, these were tested for different OTTVS to minimize solar heat gain into a building, therefore, a primary consideration in design of energy efficient buildings. Also discussed architectural techniques, types of materials on the heat transfer through the building envelope to achieve most suitable combination in the Sri Lankan context.

It was found that proper ties pertaining to thermal properties of envelope, materials, open spaces, etc helps to achieve comfort levels. There by it could be achieve balance of energy efficient and user comfort at the same time. In conclusion recommendations have been made for better envelope design.



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# INTRODUCTION

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INTRODUCTION

## INTRODUCTION.

### Background.

Buildings are significant users of energy and building energy efficiency is a high priority in many countries. Therefore efficient use of energy is important since global energy resources is finite and power generation using fossil fuels (such as coal and oil) has adverse environmental effects. Apart from above the potential for energy savings in the building sector is large.

In the present context energy efficiency of building in the design process is not much important role, consideration and also there are no sufficient information's or guidelines / design strategies to building designers in Sri Lankan context.

The present power generation of Sri Lanka only fulfills approximately half of the energy requirement of the country. According to Ceylon Electricity Board (CEB) by the year 2005 the additional energy requirement would exceed 700MW. With the recent reforms of CEB is looking for new power generation systems. (Ex. Coal power, wind power etc). However they have identified that reducing energy wastage is more important as well as economical than producing new power sources. Hence CEB has introduced set of guidelines to govern Energy efficient commercial buildings of Sri Lanka. Which helps to minimize the energy used with out loosing the comfort level of the occupants. This is known as Energy Efficient Building Code. (EEBC). However EEBC stands for commercial buildings, simultaneously it also important to save energy from the residential sector as a significant user. Basically it could implement energy efficiency through improvement of the OTTV (Overall Thermal Transfer Value) of the envelope, which directly effect on architectural portion of electrical energy consumption.

Man likes to live in comfortable conditions, and also in an aesthetically pleasing building. Therefore building without services is considered uncomfortable places. Present situation servicing of buildings is highly prioritized due to climatic conditions and rapid growth of population. As a result, energy consumptions were increased significantly in the modern world.

Also in the past, most of the building owners were concerned about construction cost. But nowadays it is real worth to think of life cycle costing as well. Because of energy efficiency could be achieved through proper design, construction, operation and maintenance. Among them energy conservation, more efficient use and reduction of waste is implied. It really does not mean a discourage of the use of energy; adequate quantities of energy should be used when necessary.



## INTRODUCTION

### Topic Explanation.

Givoni states that many architectural design features of a building affect the indoor climate they do this by modifying four forms of interaction between the building and its environment.

- a. The effective solar exposure of the glassed opaque elements of the building's envelope (walls and roofs);
- b. The effective solar gain of the building;
- c. The rate of conductive and convective heat gain from, or loss to, the ambient air; and
- d. The potential for natural ventilation and passive cooling of the building.

Unfortunately most of the Sri Lankan building designers ignored these modifying factors, which will ultimately affects to the inefficient energy usage of the buildings. Hens as such building consume large amount of embodied and operational energy. The use of active system for indoor environmental conditioning is highly popular in the modern buildings in Sri Lanka. Ceylon Electricity Board has been assessed that the present power generation capacity is unable to keep up with the growing demand, which rises by 9.5% and the growth rate varies between 8-10% per annum. Furthermore, it has been predicted that the electricity demand will quadruple in the next 15 years (CEB, 1996) and will impose an additional strain on the national grid.

The residential sector as significant user category of electricity has a greater responsibility to save energy. And most of them are currently facing a problem of increasing utility bills. With the resent studies it has found the annual cost of electricity bills has been increased highly, which a significant percentage (50%). In addition, per annum increase of energy consumption is within the range of 25 to 30%.

In such circumstances, efficiency measures to reduce operational energy demand are vital, that is to save energy and use less of it. Towards this goal, an integration of architectural strategies through envelope will provide an optimum building fabric, which minimizes the energy demand for cooling of building interiors. In addition, these energy efficient measures should incorporate the following benefits,

- Reduce energy cost
- Reduce environmental impact
- Improve ambient conditions

Therefore this study is basically discussed on basic principles, technologies of energy efficient building designing which aims on minimizing solar heat gain by the building envelope, solar penetration through windows and providing comfort by passive, natural or hybrid cooling techniques. In this matter study is looking for several domestic houses with in the Kurunegala metropolitan and calculations were carried out and analyzed in terms of user comfort.



## INTRODUCTION

### **Justification.**

#### **Importance**

Building energy efficiency is a high priority in many countries. Also efficient use of energy is important. Since global energy resources are limited and power generation using fossil fuels (such as coal and oil) has adverse environmental effects. Apart from the above potential for energy savings in the building sector is large. Hence as an Architect has grater potential for promote of energy efficient buildings. To achieve that, the principals and strategies should be applied correctly. Therefore architects and engineers who incorporate energy design concepts and methods into their design projects can play a significant role in reducing energy consumption and achieving sustainable energy structure for our society.

In Sri Lanka most of the energy consumption is attributable to the construction & servicing of the buildings. As professional building designers, architects are uniquely placed to reduction of this energy consumption. When considering the residential buildings significant amount of the energy is consumed for ventilating and lighting. Also the potential of reducing energy usage in residential sector is vast. Therefore it is important to take necessary actions to minimize the energy consumption of buildings with out loosing the occupant's comfort.

### **Objectives.**

The aim of the study is to analyze the basic principles, technologies, relationship between architectural portion of energy consumption and OTTV. There by identify the ideal standards of reduce OTTV for energy efficient parameters, to produce an energy efficient domestic building. This study also examines, alternatives of the ideal combination of passive energy consumption systems too.

Hence the objective is to investigate how the basic principals and technologies could be manipulated in terms of envelope design material used to minimized against the martial forces to achieve energy efficient built piece / design. Ultimately evaluate the performance of Bio-Climatic architectural strategies in reducing energy demand and formation of an Environmental Brief for future development of the domestic places.

- To identify the ideal usage of Architectural portion of energy consumption system to achieve required comfort levels.
- Therefore identify the relationship between Architectural portion of energy demand and OTTV. There by measure that could be taken to reduce OTTV.  
-For that purpose evaluating the required building variables (through regression).
- Formulate appropriate standards & suggestions to OTTV.
- Guidelines for designs for an energy conscious design.

## A. STUDY OF STRATEGIES FOR ENERGY EFFICIENT ENVELOPE DESIGNING FOR RESIDENTIAL BUILDINGS IN SRI LANKA

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### INTRODUCTION

#### **Hypothesis.**

- Increasing the environmental temperature may cause to increase the use of artificial ventilation.
- Lower the OTTV (Overall Thermal transfer Value) -Lower the energy demand for architectural portion of energy consumption
  - Hence lower the energy demand for Artificial Ventilation and Lighting.
- There by reducing OTTV it is possible to decrease the monthly electricity bill.

#### **Method Of Study.**

The study is focused on Energy Efficient Building Design in terms of efficient envelope features in tropical hot humid climate. Further, this study was concern domestic buildings with the Kurunegala Metropolitan region. Therefore appropriate standers for a thermally comfort energy efficient buildings in Sri Lankan context is discussed. Also this study was carried out to the month of 'March 2003', which is the hottest month (Reports 2003-Metrological department Colombo) during the year 2003, which leads to more energy consumption.

The methodology makes use of an onsite thermal investigation and energy stimulations performed through cursory energy audit. thus,

- Several residential /domestic houses were identified in Kurunegala metropolitan.
- Selected building was examined in means of energy consumption. Through electricity bills.
- Calculation was carried out to examine the energy usage for separate purposes (architectural portion)  
Eg. Ventilating (architectural)  
Lighting, etc.
- Required thermal values & OTTV data has been collected on site.
- OTTV of each has been calculated and plotted against Architectural ventilation load.
- Like wise varies conditions were evaluated plotted regression graph to come out with the ideal options to create energy efficient residential buildings for Sri Lanka.
- Having identified the appropriate slandered various materials of building elements are explored by calculation to stipulate design guild lines in the select of energy efficient material for building.

## **INTRODUCTION**

### **Assumptions.**

- It is assumed OTTV will reflect the usage of energy through utility /electricity bills
- The considered houses were assumed comfortable in terms of occupancy comfort. (*Assumed all the houses were at the same comfort level*).
- Houses considered were used mainly for residential purpose and the average of 05 occupants level. (Hence the houses not fits to this frame was rejected)

### **Limitations.**

- The study is mainly concentrated on domestic/residential buildings within the Kurunegala metropolitan.
- Main cooling system considered in calculations were artificial ventilation through fans (air condition buildings is not considered)
- The research study was carried out for certain standard.
  - Average gross floor area- 150 m<sup>2</sup> or above
  - Average occupancy level- 05 persons.
- The study was limited to passive energy management features of buildings only.