Chapter 1

Introduction

1.1 Background survey and previous work

With the rapid increase in our energy bills, various efforts are made to reduce energy consumption in buildings. Most countries around the world are developing various program models aimed at reducing energy use in buildings, through conservation and various improvements of building envelope together with increased use of energy from renewable sources.

The climatic conditions and building envelopes mainly contribute to reducing the energy consumption in buildings. According to present studies, many of the buildings are inappropriate for local warm climatic conditions; as a result energy efficiencies is declining, and there is a dramatic increase in the use of fans or air-conditioning to achieve thermal comfort. When the interior temperature is above the comfort level, artificial modes of cooling are required by way of fans or air conditioners at an extra cost.

This project mainly focuses on various improvement of building envelopes that mostly exposed to climatic fluctuations. Predominantly, the building envelope consists of windows, various openings, walls, doors, roofs, floors, and etc. Aforementioned building envelopes play vital roles in accumulating of heat inside the building; the heat gain from outside can also be minimized by changing the building orientation, size of shading devices, thickness of walls and building materials.[12]

The discussion about the building materials and implementation of its improvements should be considered during early design stage. In this stage, most of developed countries tend to use various programs and models. Apparently, there is a lack of usage in various design tools and guidance in Srilankan context. Also, it may require countless effort, and an excessive time to develop an effective program or model that can be utilized to reduce energy consumption in buildings.

As a solution, it requires developing more sustainable approaches to address the problem. In this study, a mathematical model was developed for various common building elements used in Sri-Lanka. The cooling load and energy consumption were calculated utilizing a mathematical and graphical model .

1.2 Srilankan climate [4]

Sri Lanka lies in 6 - 10 of North Latitude and 80 - 82 of East Longitude. It has a maximum length of 432 km (Devundara to Point Padro) and maximum breadth 224 km (Colombo - Sangamankanda). The land area is 65,525 Sq. km, excluding the Inland water 62,336 Sq. km. The hills appear in the center and the south of center. Sri Lanka is generally a warm country.

Area	Jan-April		May-August		Sept-Dec	
	Max.	Min.	Max.	Min.	Max.	Min.
Colombo	30°C	22°C	30°C	24°C	29°C	22°C
Kandy	31°C	17°C	29°C	21°C	28°C	18°C
Nuwara Eliya	21°C	14°C	18°C	16°C	18°C	15°C
Trincomalee	32°C	24°C	33°C	25°C	33°C	23°C

Table 1.1 – Temperature variations among major cities

This has no marked seasons. A special feature is that the hot and humid lowlands. Average mean temperature along the coast is 26.7 C (80 F) and 19.7 C (66.50 F) in the hill country. In Colombo, the commercial capital, situated on the west coast, the temperature varies from 26.4 C (79.5 F) to 27.8 C (82.12 F). The relative humidity varies from 70% during the day to 90% at night. In the lowlands the climate is typically tropical with an average temperature of 27°C in Colombo. In the higher elevations it can be quite cool with temperatures going down to 16°C at an altitude of nearly 2,000 meters. Bright, sunny warm days are the rule and are common even during the height of the monsoon; climatically Sri-Lanka has no off season. The south west monsoon brings rain mainly from May to July to the western, southern and central regions of the island, while the north-east monsoon rains occur in the northern and eastern regions in December and January. [1]

1.3 Objective and scope

(i) To identify various heat gain components that contribute to room cooling load, for different building angle, and their optimization.

(ii) To impact of cooling load through different building element like wall, window glasses, roof, slab, and doors.

(iii) To identify building elements that can be influenced in cooling load.

(iv) To develop a mathematical model for common building elements used in Sri-Lanka.

(v) To implement a graphical/ mathematical model in practical application.

(vi) To identify direct impact of capacity of air-condition unit with respect to room sensible cooling load (RSCL).

(vii) To identify direct impact of electricity bill for different types of consumers in Sri-Lanka for different room sensible cooling load.

(viii) To develop mathematical model for electricity bill with respect to room sensible cooling load (RSCL).

(ix) To find out pay back period for different improvement through economical analysis.

1.4 Motivation

As air-conditioning system is the most energy consuming subsystem of a building, a slight amount of savings from air conditioning system will have a considerable direct impact on the overall energy consumption.

Most of the air conditionings manufacturers have improved performances of air-conditioning units. But it will be useful only, if it is used in improved building envelope.

1.5 Research design

The basic idea behind this research was to identify the various impacts on building envelope and energy optimizations. The primary ideas and impacts behind this research were identified through literature review and simulated results. Subsequently, the research was evaluated against the scope of the research. The analytical aspect of the research was completed through case studies utilizing two building types, residential and commercial.

1.5.1 Steps of research

The research was carried out utilizing following steps. Each of these steps listed were included the activity that were come together with various suggestions and limitations.

1.5.1.1 Identification of the topic and scope

In order to identify the exact scope, the idea was evaluated against the requirements, and the partial fulfillment of the Degree of the Master of Science in Electrical Installation, and Implementation of the building which require simulation software (DEROB-LTH).

1.5.1.2 Research methodology

In order to fulfill the above objective the following methodology was used.

(i) A detail literature review was carried out to determine the methodology. The theories for energy interaction of the building and psychometric chart was also reviewed. A literature review was also carried out to determine the impact of internal and external factors in building energy consumption.

(ii) Series of computer simulation was carried out by using DEROB-LTH software. This tool was used to collect peak cooling load which was passed through common materials, with different building orientations.

(iii) The passing peak heating load was converted in to graphical and mathematical model and later used in application.

(iv) Two types of case studies were selected as follows.
  - (a) Case study 01 : Residential building .(Two storey house)
  - (b) Case study 02: Commercial building .(Super market)

(v) The cooling load for residential house was calculated utilizing software simulation tool (DEROB-LTH).

(vi) To justify the software validity, and the applicability of the equation developed , the theoretical results were compared with the practical results .

(vii) The mathematical and graphical results were used to calculate the load in building and to analysis of its impact.