DAYLIGHT UTILISATION IN COMMERCIAL BUILDINGS AND POTENTIAL ENERGY SAVINGS

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(08/8603)

Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

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Thesis submitted in partial fulfillment of the requirement for the degree Master of Engineering

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DECLARATION OF THE CANDIDATE AND SUPERVISOR

I hereby declare that this thesis entitled "Daylight Utilisation in Commercial Building and Potential Energy Saving" submitted to University of Moratuwa is record of original work done by me under the guidance of Prof. R.A. Attalage, Deputy Vice Chancellor, University of Moratuwa, and this project report is submitted in the fulfillment of the requirement for the degree of Master of Engineering in Energy Technology. The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma and it does not contain any material previously published, written or orally communicated by another person or myself except where due reference is made in the report.

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C J. G. M. Korale

Abstract

Energy is one of the most vital contributions to sustainable development strategy of Sri Lanka. However, the rising cost of energy generation, the depletion and the unpredictability of availability of energy resources and the adverse impacts of energy generation and its usage on the environment, have been causing much anxiety and great concern from recent times. Within this context, buildings have been considered as one of the largest consumers of energy and have therefore been identified as one of the target areas for energy conservation. Statistics have revealed that the proportion of energy consumed for lighting in buildings is much greater than what is consumed individually for providing thermal comfort or other ancillary services.

Therefore adding of daylight for space, architectural designing has become a vital overcomes above problems. Adding adequate sunlight, integration with artificial lighting and reducing the cooling load on HVAC systems are effectively providing wide energy savings in buildings and houses.

The principle objective in this research is therefore to explore strategies of designing buildings with optimal utilisation of natural light, efficient application of electrical energy for interior lighting and minimising energy usage of HVAC systems. A simulation modelling on daylight implementation was carried out under this research, with different kinds of lighting arrangement against a few different external characteristics within the control of the designer. The computer simulation software DIALUX 4.11 version was used to analyse illumination level inside the building and an extensive literature survey on maximising utilisation of daylight and its effect on HVAC system was also carried out under this research project.

As per the research energy savings from daylight design in buildings cannot be realized unless the electric lights are dimmed or switched in response to the amount of available daylight. The analysis results shows, that there is potential for saving 51% of energy consumed for building lighting with daylight implementation for the building. But due to practical limitation, existing lighting arrangement is not suitable for daylight implementation and therefore new lighting arrangement was considered under this research and new lighting arrangement shows that there is potential for 50% of energy saving with daylight integration.

The analysis was further carried out for new type of luminaries to find out further energy saving potential with implementation of energy saving lights with integration of daylight. This analysis results shows, that there is potential for 52% of energy saving with new type of luminaries and its arrangement. Effect on HVAC system due to daylight implementation was also analysed and it is shown that there is 10% increase of building cooling load due to daylight implementation.

Also this research presents guide lines for designing of daylight efficient buildings lighting systems to contribute towards energy conservation, environmental protection and establishment of sustainable economic system as well. This research can be further extended to analysis for different kind of building with different wall colouring and internal objects arrangement for optimal energy saving with daylight implementation for commercial buildings.

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LIST OF ABBREVIATIONS

Abbreviation	Description
LEED	Leadership in Energy and Environmental Design
SL	Sri Lanka
CO_2	Carbon Dioxide
HVAC	Heating, Ventilation and Air Conditioning
UV	Ultra Violet
fc	Foot Candle
EMR	Electromagnetic Radiation
h	Altitude
A	Azimuth Angle
Z	Zenith Angle
3D	Three Dimensional
dn	Day Number
E_{ext}	Extraterrestrial Solar Radiation
Esc	Solar Illiuminance Constant
Edn	Direction Normal Radiation
TDD	Tubular Daylight Devices
SHGC	Solar Heat Gain Coefficient
SC	Shading coefficient
OITC	Out to Indoor Transmission Class
WWT	Window to Wall Ratio
VT	Visible Transmission

AL	Artificial Light
DL	Daylight
CEB	Ceylon Electricity Board
CFL	Compact Florescent Lamp
LED	Light Emitting Diode
IES	Illuminating Engineering Society
n.d.	No Date
CCHRC	Could Climate Housing Research Center

LIST OF APPENDICES