DESIGN OF ENERGY EFFICIENT LIGHTING FOR EXPRESSWAYS IN SRI LANKA BASED ON TRAFFIC VOLUME

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Degree of Master of Science in Electrical Installations

Department of Electrical Engineering

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Dissertation submitted in partial fulfillment of the requirements for the degree

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.
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……. ……
A.M.B. Uduwerella Date

The above candidate has carried out research for the Masters dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

…….. ……
Prof. N.K. Wickramarachchi Date

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ABSTRACT

Among many number of methods available for demand side management, energy efficiency programs are a key component. This may involve providing energy efficient technologies, use energy efficient best practices and conducting energy audits for improving energy inefficiency of a consumer's energy utilities. Street lighting systems are excessive energy consuming component in a country among other energy consuming areas such as buildings, electric appliances, and industrial processes.

Sri Lankan Expressways consume a substantial amount of energy for lighting compared to demand from other type of street lighting, mainly due to the inefficient street lighting system in use at present. Therefore, this work was undertaken to design an energy efficient, traffic-volume based street lighting system for the expressways in Sri Lanka by taking Southern and Outer Circular Expressways as case studies.

This research presents the resulting improvement to the energy efficiency of the existing street lighting system in Sri Lankan Expressways by adopting energy efficient techniques, energy efficient standards that are used worldwide. It optimizes the illumination levels by accounting for such factors as the variable traffic volume during nighttime, other environmental factors that impact the illuminance level of expressways, transport specific aspects and features of the Sri Lankan Expressways. Further, this work also takes into account statistics on hourly traffic volumes, nighttime crashes, presence or absence of parked vehicle, pedestrians and instructions and directives that are enforced on Sri Lankan expressways.

Major findings of this research are that the existing expressway lighting system is totally obsolete in terms of technologies it uses. Present system is found to be an overdesign that is suitable for normal highways, but not optimised for Sri Lankan Expressways which are access-controlled. A new design is carried out using one out of three energy efficient lighting design methodologies which are discussed and analysed at length. It is shown that a more energy efficient lighting system could be designed without significant impact on nighttime crashes by replacing the current sodium vapour lamps with energy efficient LED lamps. This results in significant energy savings with minimized operation and maintenance costs.

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LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
ANSI	American National Standards Institute
BS	British Standard
CEB	Ceylon Electricity Board
CFL	Compact Fluorescent Lamp
CIE	International Commission On Illumination
CRI	Colour Rendering Index
DC	Direct Current
EOM&M	Expressway Operation Maintenance And Management Division
FC	Foot Candles
HPS	High-Pressure Sodium
IES	Illuminating Engineering Society
ILP	Institution Of Lighting Professionals
LED	Light Emitting Diode
LKR	Sri Lankan Rupee
LLMF	Lamp Lumen Maintenance Factor
LOR	Light Output Ratio
MH	Metal Halide
MV	Mercury Vapour
NAASRA	National Association of Australian State Road Authorities
O&M	Operation And Maintenance
PLG	Professional Lighting Guide
RDA	Road Development Authority
TI	Threshold Increment
UK	United Kingdom
US	United States
USA	United States Of America
VLR	Veiling Luminance Ratio