

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

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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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A.M.B. Uduwerella - May, 2024

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 |