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**DEVELOPMENT OF AN EMISSION ESTIMATION MODEL  
FOR TRAINS USING DRIVING CYCLE CONCEPT**

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Degree of Master of Engineering

Department of Civil Engineering

Faculty of Engineering

University of Moratuwa

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Thesis submitted in partial fulfillment of the requirements for the Master of  
Engineering in Civil Engineering

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## **Abstract**

This study develops an emission estimation model for the route having the highest emission, using the Driving Cycle concept to analyze the train emissions in Sri Lanka, aiding policy development by determining threshold values to meet future emission reduction targets. Selection of the route for the highest emission is selected based on the vertical alignment of the railway track. The onboard measurement method collected train speed data, analyzed using Python. The micro trip-based method was chosen to develop a driving cycle, as it is most suitable for emission estimation purposes.

Analysis of slow and express trains, including locomotive and power-set types, reveals that slow trains have significantly higher idling times due to frequent stops. In contrast, express trains allocate more time to acceleration and cruising. When developing driving cycles (DCs), the mean relative difference (MRDi) factor was considered, using averages of acceleration, deceleration, speed, and running speed. The MRDi values for selected DCs were 1.246% for locomotive express, 1.191% for power-set express, 0.105% for locomotive slow, and 0.179% for power-set slow trains. Express trains showed higher MRDi values due to a smaller pool of micro trips for their combinations compared to slow trains, highlighting differences in operational characteristics between the two train types.

After developing driving cycles for all train types, a connection between speed and smoke density ( $k$ ) was determined. To derive this relationship, correlations were first developed between RPM (revolutions per minute) and speed, as well as between RPM and smoke density ( $k$ ). These correlations were then used to determine the relationship between speed and smoke density ( $k$ ). Comparing the emissions to the diesel engine threshold ( $k=4$ ) indicated that locomotive trains should adhere to the 81st percentile regulation, while power-set trains already conform to Sri Lanka's existing emission standards. If the threshold smoke density values are further lowered to enforce stricter emission regulations without enhancing train engine performance, it has been observed that the travel distance decreases at nearly the same rate.

In summary, this study facilitates future studies on emission estimation economically and collaborates with the proposed emission factors. It will help to make a policy decision for measuring, regulating and imposing restrictions on the emission of trains.

*Keywords: Emission, Driving cycle, Train, Smoke density*

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