TECHNICAL NOTE

THROUGH KERBSIDE LANE UTILISATION AT SIGNALISED INTERSECTIONS

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ABSTRACT

Lane under-utilisation is the unequal distribution of traffic travelling in the same direction within available traffic lanes of a particular intersection approach. It is common in the urban environment where many intersections have short lanes, resulting in significant effects on intersection capacity.

A research study was undertaken to gain an understanding of the under-utilisation problem at signalised intersections, where short lanes have been installed to increase capacity. Ways of encouraging more even utilisation was also investigated.

Many practitioners may not be fully aware of the causes and effects of lane under-utilisation. This issue is also not addressed by modelling without manual intervention and can often lead to overestimating benefits attributable to intersection upgrades. Results showed that auxiliary lanes are usually under-utilised and that there are many factors influencing usage. It was impossible to obtain conclusive results on how each factor influences lane utilisation due to the small sample.

The research findings will be presented to raise awareness of this problem amongst industry practitioners.

Research with a larger sample, including overseas sites, is recommended with a view to developing a model that satisfactorily predicts lane utilisation. Trialling of alternative treatments improving utilisation is also recommended to measure the effectiveness of treatments.

INTRODUCTION

Lane under-utilisation at signalised intersections can be described as the unequal distribution of traffic, travelling in the same direction, within the available traffic lanes of a particular approach. It has significant effects on intersection capacity, which has consequences for congestion. Little research has been undertaken in New Zealand and Australia on this topic. Lane under-utilisation is attributable to causes varying from intersection design features to driver perception when selecting available lanes.

Road Controlling Authorities seldom implement intersection improvements just to increase lane utilisation. However, other intersection capacity improving techniques, such as signal coordination and optimisation are often adopted. It is suggested that further efficiencies can be realised if the above techniques also encompass improvements to lane utilisation. Improving lane utilisation at intersections would contribute to reducing overall levels of congestion and vehicle emissions into the environment.

The type of lane configuration used at signalised intersections is possibly the main reason why lanes are utilised differently by drivers. This study focuses on the three through lane intersection configuration as observations had shown that the lane under-utilisation problem tends to manifest itself more noticeably in the larger three through-lane intersections than two through-lane or single through-lane intersections, as motorists.

FACTORS THAT INFLUENCE LANE UTILISATION

Factors affecting lane utilisation are identified with the aim of providing an overall knowledge base of the lane utilisation problem in New Zealand. Thirteen factors in total have been identified, however, the most important factors influencing lane utilisation are:

- Auxiliary lane length
- Shared lanes
- Lane blockage
- Side friction.

All intersections are influenced by a combination of the identified factors, and increasing the number of these factors at a particular intersection is likely to result in poorer rates of utilisation. By understanding the effects of lane under-utilisation and the various factors that cause it, more realistic assessments of the expected lifecycle and economic feasibility would be possible when undertaking intersection improvement work.

DATA COLLECTION METHODOLOGY

Royce, B. Jurisich, I and Dunn, R.C.M. (2006) hypothesised that where auxiliary lanes are provided to increase intersection capacity, the length of these lanes is the main contributory factor to lane under-utilisation. This study therefore investigates the effect of auxiliary through-lane lengths on utilisation of the auxiliary lane.

Data for thirteen sites (seven 2-Laners and six 3-Laners) was analysed. The data collected for these sites included geometric data, traffic volume and movement count data and signal information. Traffic volume data was collected either by using SCATS counts, or manual counts at the stop line at each site during both the commuter peak periods and also during the midday off-peak period (OP) to assess usage during lighter traffic conditions.

To minimise the number of variables, the intersections chosen as study sites were limited to those with short upstream and downstream lanes with exclusive left and right turn lanes.

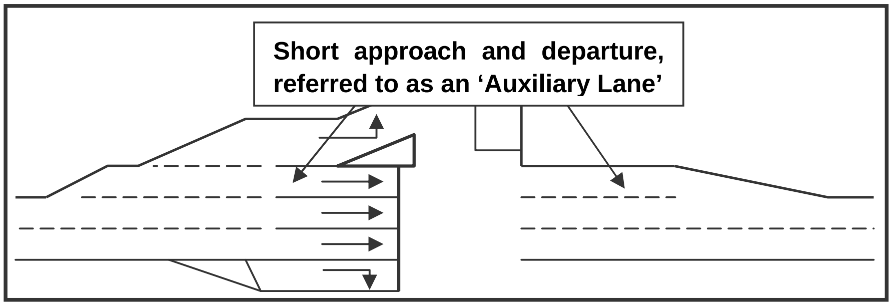

Figure 1: Typical 3-Laner with short approach and departure auxiliary lanes

DATA ANALYSIS

An initial review showed that 2-Laners and 3-Laners display different operational characteristics with differing lane utilisation effects. In ideal circumstances the rate of use of each lane would be equal, therefore being 50% in the 2-Laner scenario and 33% for 3-Laners. In the case of 2-Laner intersections the results showed that lane under-utilisation is less of a problem but 2-Laners tend to display more variable rates of lane utilisation. Therefore there is potentially greater value in researching the high volume 3-Laner situations where intersection capacity is a primary consideration.

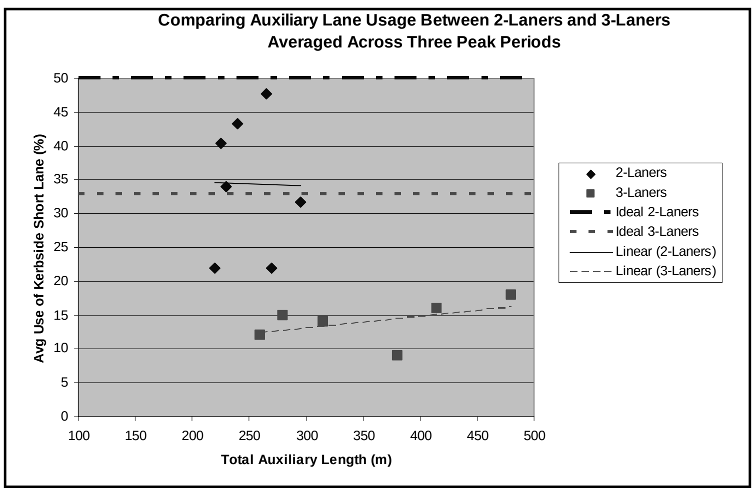

Figure 2: Comparing short kerbside lane use between 2-Laners and 3-Laners

Data for 3-Laners was analysed and the rate of use of the auxiliary lane (shown as a percentage of the overall through traffic volume) was compared to the length of that lane, during the AM, PM and Off-peak periods. This initial comparison showed that, in the case of the 3-Laners, a positive relationship between lane use and the total length of the auxiliary lane generally held true for the sample sites.

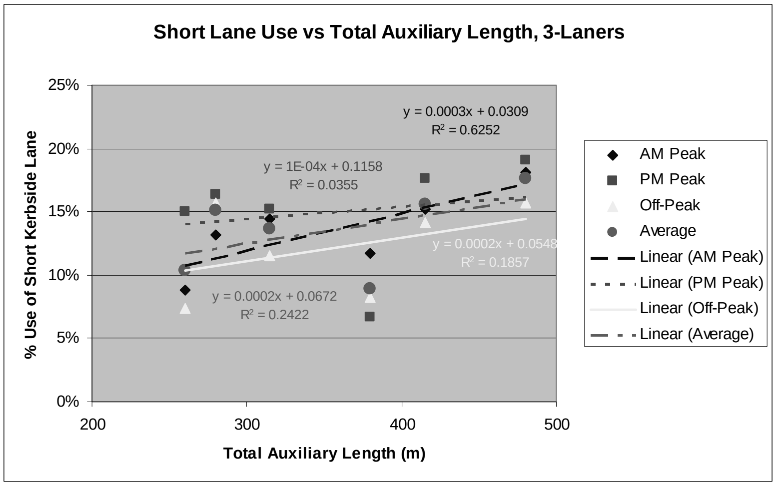

Figure 3: Scatter plot showing short lane use vs total auxiliary length for 3 – Laners

Comparisons were also undertaken against the upstream and downstream lane lengths independently to try and identify how these factors stronger influence utilisation of the auxiliary lane. The investigation revealed that the downstream lane length had a marginally stronger influence on the utilisation of the auxiliary lane. However, the auxiliary lanes of 3-Laners are generally greatly under-utilised regardless of its length. This could be attributed to the fact that drivers have more choice between which through-lanes they use and that, in addition to the site specific factors that influence lane utilisation, drivers prefer to position themselves in the right and middle lanes.

Further analysis for each of the 6 3-Laner approaches was carried out comparing auxiliary lane utilisation against time of day. The main trend identified from this analysis was that lane utilisation of the auxiliary lane increased during the tidal peak period, i.e. when traffic demand is higher. The results showed considerable variability of lane utilisation throughout the day and it was thus considered that for a true like-for-like comparison between the performance of various approaches only the peak hour should be used. The figure below is a scatter plot showing the utilisation of the auxiliary lane against the total auxiliary length for the tidal peak period only. A positive relationship resulted, however, this was not particularly conclusive as the sample is too small to bring confidence in the outcome.

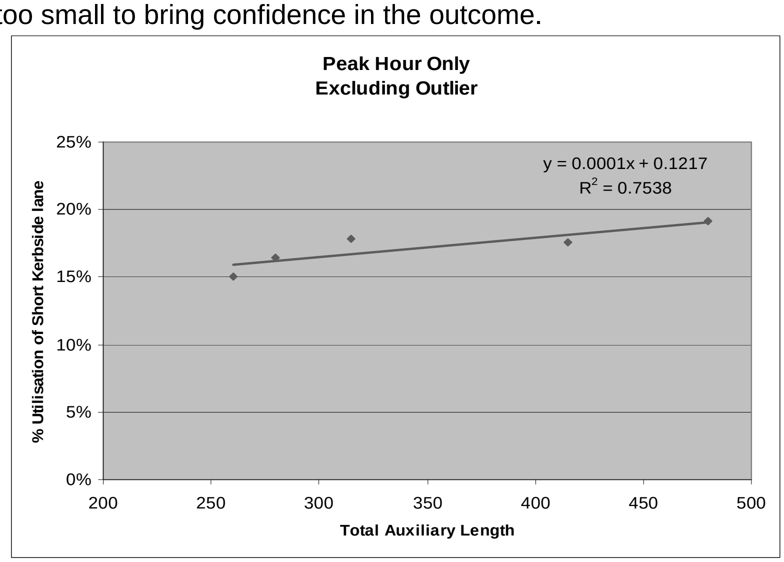

Figure 4: Scatter plot showing short lane use vs total auxiliary length for 1 peak only

A basic comparison between field data and the formulas used by Akcelik (1995) ARR 123 and Sidra Intersection was also undertaken. This showed that the method employed in Sidra Intersection to account for the effects of lane under-utilisation greatly over-estimate the actual utilisation. This indicates that the default parameters and model used in Sidra Intersection for predicting the utilisation of auxiliary lanes are not well suited for New Zealand conditions. In the case of 3-Laners, the equation from Akcelik (1995) ARR 123 is more reflective of how short auxiliary lanes, are used in NZ. I.e. qT1=qT/6, where:

qT1 = the through-traffic flow in the under-utilised lane, and

qT = the total through-traffic flow.

MEASURES TO IMPROVE LANE UTILISATION

The widely varying rates of auxiliary lane utilisation indicate that intersection design has a strong influence over this aspect of the operation. A draft auxiliary lane design guide has been prepared and brings together guidelines and learnings from this study. The design guide is only a starting point and further research would lead to refinements and additional evidence to back up guidance. The guide includes recommendations on lane length, length of merges and diverges, sight distances and lane width.

CONCLUSIONS

Analysis of the lane usage rates show that in the most situations, the utilisation of short lanes is far below the ideal rate. Utilisation rates for short lanes in the 2-Laner situation ranged between 18% and 49%, averaging about 34% across all sites. Utilisation rates in the 3-Laner situation ranged between 7% and 19% averaging approximately 14%.

The results of the study show a positive relationship between lane length and utilisation, however, it was not found to be a strong link. Increasing auxiliary lane length only resulted in minor improvements in lane utilisation. Results indicate that a 100m increase in total lane length would improve lane utilisation by 1.4% on average for 3-Laners. Based on the sample analysed in this study, it is therefore concluded that increasing the total upstream and downstream length of the short kerbside through-lane is likely to result in only marginally higher rates of use.

Key conclusions from the study include:

- Previous study looked at comparing peaks i.e. AM with AM, PM with PM and so forth. We found each intersection had differing peaks (because of tidal flow) and a more realistic comparison was determining the actual peak of each intersection and rather comparing “approach peaks” for each sample.

- The relationship between uitlisation and length was found to not be as strongly correlated as indicated by earlier studies.

- If Sidra Intersection was used to estimate capacity for each of the sites analysed in this report, using default values lane utilisation of the auxiliary lanes would have been significantly over estimated in all but one case.

RECOMMENDATIONS

Four low cost alternative / improvement treatments have been suggested as part of this Study and are closely aligned with the New Zealand Transport Agency’s principles of employing cost effective measures to improve network operation and ultimately ease congestion. The four treatments are as follows:

1. Auxiliary lane on the right;
2. Advance lane designation signage and road marking;
3. Converting auxiliary lanes into bus or transit lanes
4. Phasing and cycle time changes.

It is also recommended that two of the alternative treatments discussed above i.e. the “auxiliary lane on the right” and the “advance lane designation signage” are trialled to determine how effective they are in influencing the rate of use of auxiliary lanes. The objective of the trial would be to identify measures that result in a more even distribution of lane utilisation, and therefore more efficient intersection operation. The trial would be a valuable exercise as both treatments will be representative of potentially low cost improvement to increase lane utilisation at signalised intersections.

The number of sites with short though-lanes in NZ is limited, and the sample size used in studies to date is less than satisfactory. It is therefore recommended to include sites from Australia, since traffic characteristics and operation is similar to NZ. If enough sites are identified it may be possible to develop a prediction model that can be used for assessing the operation of proposed intersection improvements that include auxiliary lanes.

A draft design guide for auxiliary lanes has been developed and provided in this report. However, here are various areas of this guide that are lacking evidence to confirm some of the guidelines. This draft design guide should be further developed based on trials and/or wider research. The design guide will aim to mitigate some of the factors affecting lane utilisation listed previously and could include suggestions for other alternative trials.

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