INCIDENT CAPACITY REDUCTION ON FOUR-LANE FREEWAYS USING REAL WORLD DATA: MULTILANE CLOSURES

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Abstract

One of the main goals in incident management is to reduce delay and queuing caused by an incident. Delay and queuing are among other things dependent on the road capacity, so an accurate estimate of the capacity reduction can potentially lead to improved efficiency of incident management and delay reduction. In this study a new method based on the slope of the cumulative counts is proposed to estimate capacity reductions at the incident site. The method is applied to real world incident scenarios on four lane freeways in Maryland and Northern Virginia. Thirty-two incidents from Maryland and nineteen cases from Northern Virginia meet the requirements to apply the proposed methodology. Results indicate that except for shoulder accident cases, the estimated available capacity ratios during incidents are significantly different from those reported in HCM. It is found that in cases where one driving lane is blocked, the available capacity reduces to 70%. This value reduces to 39% and 17% for two lanes closure and three lanes closure scenarios, respectively. Moreover, it is found that besides less available number of lanes, less efficient use of driving lanes due to changes in driver behavior and distractions is another contributing factor to capacity reduction.

Methodology

Introduction

- This study reports the ratio of available capacity due to incidents in four-lane freeways based on Maryland and Northern Virginia data by estimating the maximum throughput at the location of incidents.
- Different real world incident scenarios are studied and the results are compared to the values reported in Highway Capacity Manual.
- Incidents are categorized in five separate groups based on their lane closure patterns as: shoulder incident, shoulder incident, one lane closed, two lanes closed, and three lanes closed.
- Significance of Study: Use of real-world data for capacity reduction estimation.
- Development of a new algorithm in incident capacity estimation based on cumulative counts to avoid difficulties in dealing with random variations in vehicle counts, and ensure estimated flow rates are calculated as the capacity.
- Capacity reduction analysis on four-lane freeways, except in HCM there is no other published work addressing the issue of capacity reductions on four lane freeways.

Data

- Incident Data on Maryland and Northern Virginia four-lane freeways obtained from the CHART and VDOT respectively for a period of five years from January 2008 to October 2014.
- In total 51 incidents selected from different locations along I-495 and I-66 highways.
- Traffic Data accessed through detector query tools in RITIS at one minute interval resolution.

Case Study

- Incident Selection: Two main criteria were considered in the process of incident selection: 1. Proximity to traffic detector (within maximum one-mile distance from upstream and downstream detector), and 2. Bottlenecks identified using two speed thresholds: a. Traffic with speed less than 45 mph at upstream detector and b. Traffic with speed more than 50 mph at downstream detector.
- Incident Capacity Estimation: A new algorithm is used to estimate capacity during incidents. Capacity is estimated as the slope of the cumulative count curve. Breakpoints are identified by fitting two straight lines to the curve using Broken Stick Piecewise Regression estimation model.
- Non-Incident Capacity Estimation: Capacity is estimated using the remaining lanes during normal conditions.
- Capacity Reduction Estimation: If the estimated capacity during an incident is less than the non-incident capacity the incident is categorized as a bottleneck. Bottlenecks are identified using two speed thresholds: a. Traffic with speed less than 45 mph at upstream detector and b. Traffic with speed more than 50 mph at downstream detector.

Result

- The estimated ACR under different lane closure scenarios are found to be the same (at 95% level of confidence) for Maryland and Northern Virginia freeways.
- Except for shoulder accident scenarios, our findings on ACRs are seen to be significantly different from HCM.

Conclusion

- The efficiency ratio decreases as the number of closed lanes increases.
- Road authorities may use the findings on ACR to inform the travelers about the delay they should anticipate as a result of a particular incident with known number of lanes closed.

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