COLLEGE OF ENGINEERING AND COMPUTER SCIENCE

Using Microsimulation and NGSIM Data to Validate HCM Methodology for Oversaturated Freeway Weaving Segments

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Current Highway Capacity Manual (HCM) 2010 methodology for freeway operations contains procedures for calculating traffic performance measures both for undersaturated and oversaturated flow conditions. However, one of the limitations regarding oversaturated freeway segments is that HCM procedures have not been extensively calibrated based on field observations on U.S. freeways. The goal of this study is to validate the HCM 2010 methodology for oversaturated freeway weaving segments. A VISSIM model is built based on NGSIM field data for the US 101 Highway. Abundance of the NGSIM data is utilized to calibrate and validate the VISSIM model. The southbound US Highway 101 (Hollywood Freeway) in Los Angeles, CA, is used as a case study to validate HCM 2010 methodology for oversaturated freeway weaving segment. The US 101 Highway weaving segment consists of 5 mainlines, one on ramp entrance at Ventura Boulevard and one off ramp exit at Cahuenga Boulevard, 698ft apart. An auxiliary lane is present through a portion of the corridor between the on and off ramps. The length of the whole segment to be investigated is 2100ft. Some of the preliminary results of VISSIM's model calibration show that the VISSIM model is able to accurately represent field conditions captured by the NGSIM data set.

ASSESSMENT OF HCM FREEWAY WEAVING METHODOLOGY FOR OVERSATURATED TRAFFIC CONDITIONS BY USING MICROSIMULATION

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ABSTRACT

Current Highway Capacity Manual (HCM) 2010 methodology for freeway operations contains procedures for calculating traffic performance measures both for undersaturated and oversaturated traffic conditions. However, one of the limitations regarding oversaturated freeway segments is that the HCM procedure has not been extensively calibrated based on field observations on U.S. freeways. This study validates the HCM2010 methodology for oversaturated freeway weaving segments by comparing speed and density obtained from HCM analytical procedure to those acquired from a stochastic microsimulation model. A VISSIM model is extensively calibrated and validated based on NGSIM field data for the US 101 Highway. Abundance of NGSIM data is utilized to calibrate and validate the VISSIM model. T-test is done to prove that there is no significant statistical difference between field data and VISSIM microsimulation model and that the model can be used with high level of confidence. Results show that HCM methodology has significant limitations and while in some cases it can reproduce density correctly, the study finds that speeds estimated by the HCM methodology significantly differ from those observed in the field.

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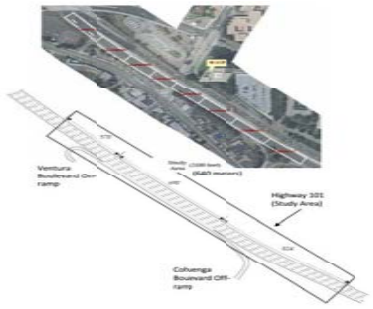
INTRODUCTION

Oversaturated traffic conditions have always been more difficult to evaluate comparing to non-congested traffic environment. HCM supports this statement, since basic methodology for directional freeway facilities cannot evaluate freeway facility when oversaturated conditions occur. Using supplemental analytical procedures contained in HCM's Chapter 25 it is possible to evaluate these conditions. The problem that needs to be addressed may be formulated as: **can HCM methodology for directional freeway facilities replicate performance measures for freeway weaving sections under oversaturated traffic conditions**. HCM methodology for oversaturated conditions on freeway weaving sections is evaluated by comparing to VISSIM microsimulation model which is built, calibrated and validated based on field data. Evaluation is done by comparing density and space mean speed obtained from HCM methodology to those acquired from VISSIM model. Premise was that HCM Methodology can replicate density and space mean speed properly and that, comparing to calibrated VISSIM values no significant differences will occur.

CASE STUDY NETWORK

The area for the study is located in southbound direction of U.S. Highway 101 in Los Angeles CA. The site was approximately 2,100 feet in length, with five mainline lanes throughout the section. An auxiliary lane is present trough a portion of the corridor between the on-ramp at Ventura Boulevard and the off-ramp at Cahuenga Boulevard.



METHODOLOGY

HCM METHODOLOGY

Overall Procedure

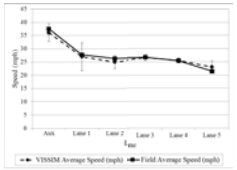
HCM Methodology Preview

BUILDING VISSIM MODEL

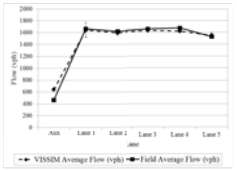
VISSIM Screenshot

HCM Weaving Segment Adjustments

Speed Calibration



Flow Calibration



RESULTS

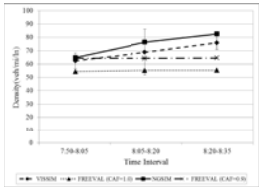
Speed and Flow Data Comparison

Time Interval	Segment	VISSIM Data		FREEVAL Data		NGSIM Data	
		Density (veh/mi/ln)	Speed (mi/h)	Density (veh/mi/ln)	Speed (mi/h)	Density (veh/mi/ln)	Speed (mi/h)
7:50 – 8:05 AM	Basic	64.0	25	95.6	20.5	79.5	20.56
	Weaving	57.67	24	54.2	32.3	60.82	23.6
	Basic	65.4	25	43.4	47.9	54.0	31.28
8:05 – 8:20 AM	Basic	72.0	20.48	95.1	21.1	87.11	17.42
	Weaving	65.0	20.09	54.2	32.2	68.55	19.49
	Basic	69.4	22.29	43.4	47.9	73.60	21.16
8:20-8:35 AM	Basic	80.6	17.26	95.1	21.1	93.9	15.19
	Weaving	70.8	17.57	55.1	31.7	75.48	16.79
	Basic	76.12	19.21	43.5	47.9	78.2	18.9

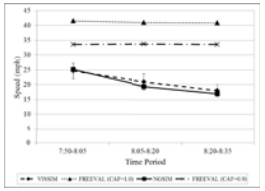
T-Test Statistics

Flow	VISSIM	FIELD	Speed	VISSIM	FIELD
Mean	1446.20356		Mean	27.18817	27.5
Variance	157878.91089		Variance	20.73445	28.40656
Observations	6	6	Observations	6	6
Pearson Correlation	0.99907		Pearson Correlation	0.98704	
Hypothesized Mean Difference	0		Hypothesized Mean Difference	0	
df	5		df	5	
t Stat	0.31804		t Stat	-0.68825	
P(T<=t) one-tail	0.38165		P(T<=t) one-tail	0.26096	
t Critical one-tail	2.01505		t Critical one-tail	2.01505	
P(T<=t) two-tail	0.76331		P(T<=t) two-tail	0.52192	
t Critical two-tail	2.57058		t Critical two-tail	2.57058	

Density Evaluation



Speed Evaluation



CONCLUSIONS

- HCM Methodology for freeway weaving segments under oversaturated traffic conditions is not able to properly replicate space mean speed
- HCM Methodology for freeway weaving segments under oversaturated traffic conditions is not able to replicate density
- VISSIM can replicate density after calibration and validation is done with no significant statistical difference on freeway weaving segments under oversaturated traffic conditions
- VISSIM can replicate space mean speed after calibration and validation is done with no significant statistical difference on freeway weaving segments under oversaturated traffic conditions
- Driving behavior parameters available in microsimulation for car following and lane changing modes play important role in replicating performance measures properly
- HCM methodology does not have option to adjust behavior of drivers; that is main reason why performance measures cannot be properly replicated
- Although analytical procedure is user friendly and easy to deploy comparing to VISSIM stochastic model, it cannot produce good performance measures – in this case density and space mean speed

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