HCM'S FREEWAY FACILITIES METHODOLOGY THE RIGHT-SIZED TOOL FOR PLANNING AND OPERATIONS

16 JULY 2020

Loren Bloomberg, PE

Global Technology Lead – Traffic Engineering and Operations



AGENDA

- HCM Freeway Analysis Options
- HCM Approach for Freeway Facilities
- ► The FREEVAL Tool
- HCM Freeway Facilities Analysis "Scope"
- Traffic Analysis Tradeoffs
- Case study: Freeway Express Lanes
- Other Opportunities for Freeway Facilities Analysis



HCM 6TH EDITION UNINTERRUPTED FLOW CHAPTERS

- Chapter 10: Freeway Facilities
- Chapter 11: Freeway Reliability Analysis
- Chapter 12: Basic Freeway and Multilane Highway Segments
- Chapter 13: Freeway Weaving Segments
- Chapter 14: Freeway Merge and Diverge Segments
- Chapter 25: Freeway Facilities Supplemental
- Chapter 26: Freeway and Highway Segments Supplemental
- Chapter 27: Freeway Weaving Supplemental
- Chapter 28: Freeway Merges and Diverges Supplemental

HCM Freeway Analysis Options

HCM 6TH EDITION UNINTERRUPTED FLOW CHAPTERS

- Chapter 10: Freeway Facilities
- Chapter 11: Freeway Reliability Analysis
- Chapter 12: Basic Freeway and Multilane Highway Segments
- Chapter 13: Freeway Weaving Segments
- Chapter 14: Freeway Merge and Diverge Segments
- Chapter 25: Freeway Facilities Supplemental
- Chapter 26: Freeway and Highway Segments Supplemental
- Chapter 27: Freeway Weaving Supplemental
- Chapter 28: Freeway Merges and Diverges Supplemental

HCM Freeway Analysis Options



HCM ANALYSIS ELEMENTS

- Generally Independent Segments
 - Basic Freeway Segments
 - Weaving Segments
 - On-Ramp and Off-Ramp Segments
 - Overlapping Segments
 - Managed Lane Segments
- Single Time Period
- Defined Demand
 - Peak hour
 - Modifications (e.g., Peak Hour Factor, trucks)

HCM Freeway Analysis Options



HCM'S FREEWAY FACILITY ANALYSIS IS MUCH MORE SOPHISTICATED

- Combines the analysis of multiple segments along an extended length of a freeway (up to 15 miles).
- Considers oversaturated conditions including queue spillback and effects on upstream and downstream flows.
- Can model queue propagation between segments and over multiple time periods.
- Considers operations over multiple (15-minute) contiguous analysis periods up to 24 hours.
- Considers interaction of parallel facilities (e.g., managed lanes).
- > Allows for multiple days (reliability analysis).

MULTIDIMENSIONAL FREEWAY FACILITIES ANALYSIS

•

One segment, one time period, one day

MULTIDIMENSIONAL FREEWAY FACILITIES ANALYSIS

Multiple

time Periods

One segment, one time period, one day



ONR-2

OFR-2

ONR-3

OFR-3

OFR-1

HCM Approach for Freeway Facilities

ONR-1







MULTI-DAY ANALYSIS CAPTURES REAL-LIFE VARIATION

Daily "noise"

Incidents

► Weather

Seasonal effects



FREWAY FACILITIES SOFTWARE

> Accounting exercise

- Track each segment and time period
- > Determine HCM-based results
- Adjust for upstream queues and downstream queue starvation
- > Options:
 - Spreadsheets (bad idea)
 - Bundled with HCS
 - ► FREEVAL



The FREEVAL Tool

FREEVAL SOFTWARE

<u>http://freeval.org</u>

- Developed by North Carolina State University
- Free software
- User guide, videos, links, Q&A
- TL;DR: Enter data on each segment and time period
- Instant results

📓 FREEVAL-2015e - Not Saved New File — 🗆 X												
Edit Sood Eacility Manage	np d Lance – Roliability Analysis	(DI)		TOM Analysis								
Cut seed racing manage	Reliability Allalysis	alysis (RL) ATOM Analysis										
Global input Fill Data Tu	rn On Generate	Delete St	immary	Configure	ary			•				
Example Project (RL/ATDM Project)	Single Seed/Scenario I/O	ompare Resul	t Contours	Analysis Peri	iod Summary	Segment	& Facility Sun	nmary		*******		
	Table Display Options	nalysis Deriod (A	D) Control	randigoto i en	ou ourninurj	orginein	or rubinty bun	initial y				
	Input CP Only				ent A Land							
	input • or only •	A.P. 1/4 17:0	0 - 17:15	First		V	Last	Jump				
		1 2	3	4	5	6	7			- 1		
										- 1		
	-			ļ						- 1		
		1	1	1		-1	1			- 1		
										- 1		
									ana			
	Segment	Seg. 1	Seg. 2	Seg. 3	Seg. 4	Seg. 5	Seg. 6	Seg. 7				
	General Purpose Se	Racio	Bacio	Pacia	Racio	Racia	Racio	Pacie				
	General Purpose Se	at Length (ff)	2 640	2 640	2 640	2 640	2 640	2 640	2 640			
	oeginei	Level	Level	2,040	Level	Level	Level	2,040				
	Truck-PC Eq	2 00	2.00	2 00	2.00	2 00	2.00	2.00				
	# of Lan	3	3	3	3	3	3	3				
	Free Flow S	70	70	70	70	70	70	70				
	Mainline	Dem. (vph)	1									
	Mainline Single Unit Tru	5.00										
	Mainline Tracto	0.00										
	Seed Capac	ity Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
14:25:20 Applysis period 1 palasted	Seed Entering De	m. Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
14:35:28 Example Project Scen#0	Seed Exit De	m. Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
selected	Seed Free Flow Spe	ed Adj. Fac.	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
14:35:28 New seed created	Seed Driver Pop. Capa	city Adj. F	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Seed Driver Pop. Free I	Flow Spee	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
	Acc/Dec Lan	e Length (ft)										
									X			
		•	•						-			

FREEWAY FACILITIES ANALYSIS FOLLOWS THE SAME APPROACH AS OTHER STUDIES

- Determine study area, scenarios, time periods
- Gather data for existing conditions
- Code, test, and validate baseline model
- Calibrate using performance measures and the eye test
- Determine future demands and alternatives
- Code and "run" future scenarios
- Extract data and develop reports



HCM Freeway Facilities Analysis "Scope"

FREEWAY FACILITIES ANALYSIS FOLLOWS THE SAME APPROACH AS OTHER STUDIES

- Determine study area, scenarios, time periods
- Gather data for existing conditions
- Code, test, and validate baseline model
- Calibrate using performance measures and the eye test
- Determine future demands and alternatives
- Code and "run" future scenarios
- Extract data and develop reports



HCM Freeway Facilities Analysis "Scope"

FREEWAY FACILITIES ANALYSIS FOLLOWS THE SAME APPROACH AS OTHER STUDIES

- Determine study area, scenarios, time periods
- Gather data for existing conditions
- Code, test, and validate baseline model
- Calibrate using performance measures and the eye test
- Determine future demands and alternatives
- Code and "run" future scenarios
- Extract data and develop reports.





HCM Freeway Facilities Analysis "Scope"

EXAMPLE PROJECT

- Congested California freeway
- HOV lanes (current)
- > Alternatives include:
 - > Widening (additional managed lanes)
 - ► Tolling
 - > Occupancy changes



BASELINE FUTURE ANALYSIS - GP

Existing GP



2035 No Build GP



BASELINE FUTURE ANALYSIS - HOV

Existing HOV



2035 No Build HOV



ALTERNATIVES ANALYSIS – EXPRESS LANES





2035 Express Lanes GP



ALTERNATIVES ANALYSIS – EXPRESS LANES





2035 Express Lanes



SAMPLE PERFORMANCE SUMMARY

					Passenger		Passenger				Density Based Level of Service					ice
			Average	Vehicle	Miles	Vehicle	Hours		Vehicle	Passenger	(Period Distribution)			ion)		
			Travel	Miles	Traveled	Hours	Traveled	Average	Hours of	Hours of	%	%	%	%	%	%
			Time	Traveled	(Pass-	Traveled	(Pass-	Speed	Delay	Delay (Pass-	LOS	LOS	LOS	LOS	LOS	LOS
			(Minutes)	(Veh-Miles)	Miles)	(Hours)	Hours)	(MPH)	(Hours)	Hours)	Α	В	С	D	Е	F
NB ~	GP	AM	16	459,731	505,704	7,974	8,771	58	1,844	2,028	0%	19%	52%	20%	4%	4%
		PM	27	638,231	702,054	18,464	20,311	35	9,954	10,950	0%	5%	29%	19%	16%	30%
	⊔∩т	AM	14	58,032	123,138	962	2,041	60	188	399	69%	13%	5%	7%	1%	6%
		PM	20	152,409	323,394	3,423	7,263	45	1,391	2,951	0%	44%	34%	9%	0%	12%
SB	GP	AM	40	380,321	418,353	16,370	18,007	23	11,299	12,429	5%	22%	29%	10%	1%	33%
		PM	20	472,509	519,760	10,733	11,806	44	4,432	4,876	6%	40%	36%	7%	1%	9%
	HOT	AM	44	87,032	184,671	4,390	9,314	20	3,229	6,852	26%	27%	13%	1%	1%	33%
		PM	14	78,825	167,257	1,273	2,700	62	222	470	66%	22%	10%	2%	0%	1%
			GP	1 950 792	2 145 871	53 540	58 894		27 530	30 283						
				376 208	708 /50	10 047	21 218		5 030	10,200						
				0.007.000	1 90,409	10,047	21,310		3,030	10,072						
			iotai	2,327,090	2,944,330	63,587	80,213		32,559	40,955						

RELIABILITY ASSESSMENT



RELIABILITY ASSESSMENT

- ► 144 scenarios
 - Demand variations (PeMS)
 - Incidents (range)
 - Weather (local)
- Performance metric: travel time reliability index
 - % of trips with Travel Time Index (TTI) < 3.0 (3x free flow)
 - Introduced as one of the ways of assessing alternatives
 - ► Travel time, delay, LOS, reliability



OVERALL ASSESSMENT (PM AND TECHNICAL)

Better than simulation

- > Much faster (at least twice as fast)
- > Flexibility as alternatives changed
- Easy output processing (spreadsheet-based)
- HCM base
- New reliability "toy"
- Limitations
 - ► No animation
 - > Simplistic model for weaving at access points
 - Straight pipe only
 - No intersections (Synchro)

OTHER OPPORTUNITIES

- Work Zones Lane Closure Scenarios
- Demand Variations (COVID Recovery)
- Active Traffic Management/Dynamic Lane Control
- Effects of Incidents/Incident Management



Other Opportunities for Freeway Facilities Analysis

HCM'S FREEWAY FACILITIES METHODOLOGY THE RIGHT-SIZED TOOL FOR PLANNING AND OPERATIONS

16 JULY 2020

Loren Bloomberg, PE

Global Technology Lead – Traffic Engineering and Operations

