THE URBAN FREEWAY CONGESTION PROBLEM

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Urban traffic congestion is not a new problem. Virtually from the introduction of automobiles into the transportation system, there have been congestion problems. But in recent years the congestion problem has become much more serious and truly national in scope. In fact, the residents of several cities, including Phoenix, Atlanta, Houston, San Francisco, and Washington have all identified traffic congestion as their most serious regional problem (1). As citizen concern has grown, the news media, which once covered congestion-related stories only rarely and on back pages, now cover traffic congestion much more frequently and as front page news.

As an example of how traffic congestion can affect individuals, consider the example of a 20 year-old worker in an urban area who has a 40 minute commute each way to work. An average of ten of these forty minutes are spent being delayed due to congestion. In the course of a working lifetime (to age 65), assuming conditions do not worsen, this worker will be delayed by a total of nearly 4,000 hours, or about two working years.

Congestion on urban freeways causes particularly serious problems, because of the freeway's role as the backbone of the urban transportation network. Freeways account for less than three percent of the roadway milage in urban areas, yet accommodate over 30 percent of the total vehicle-miles of travel (2). Severe congestion on an urban freeway will typically spill onto adjacent arterials and local streets and further aggravate the overall congestion problem.

There are two basic types of freeway congestion. The first is recurring congestion, which occurs in the same locations on a daily basis. Recurring congestion is normally caused by the combination of heavy traffic demand and some sort of bottleneck. This may be a lane drop, particularly heavy traffic flow at an on or off-ramp, a steep grade, a weaving section, or a roadway segment with a particularly narrow cross section, such as a bridge.

The second type of freeway congestion is nonrecurring congestion, which is caused by random, but not infrequent events, such as disabled vehicles, accidents and adverse weather. Congestion due to planned events, such as a large sporting event or maintenance and construction work is also considered to be nonrecurring congestion. However, since these events are planned, their impact on freeway congestion can be calculated in advance and appropriately mitigated. Delays due to nonrecurring congestion can be very minor, such as those caused by a disabled vehicle on the shoulder, or quite major, such as those caused by a an accident which blocks all available freeway lanes.

In order to quantify the magnitude of the urban freeway congestion problem on a national scale, the Federal Highway Administration (FHWA) sponsored a study in 1986 (3) to analyze the problem based on highway performance data submitted to FHWA by the States. The methodology used in this study was based largely on the freeway capacity and level of service procedures contained in Chapter 3 of the 1985 Highway Capacity Manual (4). Estimates were made for delay due to recurring congestion, delay due to nonrecurring congestion, excess fuel consumption, and excess user costs, based on assumed values of user travel time and wasted fuel. Estimates were made for both 1984 and 2005 assuming no improvements to the urban freeway system.

The results of this study are shown in Table 1. It was found that urban freeway congestion led to over 1.2 billion vehicle hours of delay, over 1.3 billion gallons of wasted fuel and over 9 billion dollars in excess user costs in 1984 alone. Over 60 percent of the wasted delay, wasted fuel and excess user costs were due to nonrecurring congestion caused by incidents. These figures were recently updated for 1985 and ita was found that there had been a nearly 30 percent increase in delay between 1984 and 1985 (5).

As astounding as the figures for 1984 and 1985 are, the results of the study for 2005 are positively alarming. Delay, wasted fuel and excess user costs will all increase more than fivefold unless substantial improvements to the urban freeway system are made. Over 70 percent of improvements to the urban freeway system are made. Over 70 percent of all delay will be due to nonrecurring congestion caused by incidents.

There are two basic types of strategies for addressing urban freeway congestion problems: adding capacity and reducing demand. The most direct way to add capacity to the freeway is to add lanes. Unfortunately, this type of improvement is also very expensive, highly disruptive to traffic already on the freeway, and in many areas, infeasible due to right-of-way, terrain, or political constraints. Capacity can also be added to the freeway by implementing low-cost measures, such as narrowing existing lanes to gain an additional lane, allowing travel on the shoulder during peak periods, lengthening acceleration and deceleration lanes, widening on and off ramps, or closing selected ramps during peak periods. These types of projects have been successfully implemented in many locations throughout the country.

The traffic carrying capability of a freeway can also be improved by managing the traffic with a computerized surveillance and control system. These systems generally consist of four major components:

1) A surveillance system to monitor the flow of traffic on the freeway and identify problems. This is generally done using electronic loop detectors, closed circuit television or both.

2) Control of the flow of traffic entering the freeway using signals at entrance ramps. The purpose of these signals is to "meter" the rate of traffic entering the freeway at a rate that can be absorbed.

3) An incident management program to quickly and effectively respond to, manage the impacts of, and clear both major and minor incidents. Such a program requires a significant commitment of both personnel and equipment to be effective.

4) An effective information system to keep motorists informed about traffic delays and appropriate alternate routes. This is currently done using changeable message signs, commercial radio traffic reports, or highway advisory radio; however, in-vehicle route guidance systems show a great deal of promise for performing this function in the future.

The second type of strategy to reduce congestion on urban freeways is to reduce traffic demand during peak periods by shifting demand into higher occupancy vehicles or by shifting demand outside the peak period. This can be done in a variety of ways, including ridesharing, widespread use of staggered work hours and flextime, priority treatment for high occupancy vehicles, or charging tolls to motorists who drive alone or during the peak period.

This specialty conference concentrates on mitigating the impacts of nonrecurring congestion, typically the cause of more than half the delay on the urban freeway system. Both strategies that increase freeway capacity and those that reduce demand can be used to reduce the impacts of nonrecurring congestion. Strategies which increase capacity do not directly reduce the overall incident rate, but can reduce the number of minor secondary accidents which tend to occur under congested conditions. These strategies also provide additional capacity when an incident occurs, which reduces the time required for traffic flow to return to normal after the incident is cleared. Strategies which reduce demand have more direct impact on the overall incident rate, since this rate is closely correlated to the number of vehicle-miles of travel on the freeway. If total vehicle-miles of travel are reduced =, the incident rate will typically be reduced as well.

The primary goal of an incident management program is to minimize the impacts of incidents on traffic flow. This is generally accomplished in two ways:

- reducing the duration of the incident
- efficiently managing traffic during the incident

These two goals can, in turn, generally be achieved by:

- reducing the time needed to detect that an incident has occurred
- reducing the time for response personnel and equipment to arrive at the scene
- exercising proper on-scene management of personnel and traffic
- reducing the time needed for the incident to be cleared from the roadway
- providing timely and accurate information to the public

Table 2 lists some ways that these goals can be achieved in an overall incident management program. Some of these actions are effective for all types of incidents, some apply only to "routine" minor incidents, while others are clearly intended to address the problems associated with major incidents. The strategies selected by an agency for a particular freeway will depend on the specific incident problem and the resources available. It should be noted while major incidents such as multi-lane accidents or hazardous material spills cause large amounts of minor accidents and vehicle disablements are far more common and can easily cause as much traffic congestion as a major incident if not properly managed.

An important item to note from Table 2 is that freeway incident management is truly a multidisciplinary activity. All of the key players, such as those from the highway agency (both traffic and maintenance), police agencies, and fire/rescue agencies, as well as other involved agencies, must be committed to making the incident management program work. Without the involvement and commitment of all necessary parties, the incident management program will never be truly successful.

Urban freeway congestion is general and nonrecurring incident congestion in particular are serious and growing problems. Incidents on urban freeways cannot be prevented entirely; however, proven existing techniques to address the nonrecurring congestion problem can minimize the delay caused by incidents. A systematic and vigorous application of these techniques is required if our current urban freeway congestion problem is not to grow to an intolerable level.

Table 1. Urban Freeway Congestion Statistics

	1984	2005
Freeway Miles	15,335	15,335
Vehicle-Miles of Travel (millions)	276,635	410,987
Recurring Delay (million vehicle-hours)	485.0	2,048.6
Delay Due to Incidents (million vehicle-hours)	776.8	4,857.5
Total Delay (million vehicle-hours)	1,251.8	6,906.1
Total Wasted Fuel (million gallons)	1,377.5	7,317.1
Total Excess User Cost (billion dollars)	9.2	50.0

Source: Reference 3

Table 2. Candidate Incident Management Techniques

TECHNIQUES FOR REDUCING DETECTION TIME

- Electronic loop detection
- Closed circuit television
- Call boxes
- Service patrols
- CB radio monitoring
- Increased police patrol frequency
- Stationing fixed observers at strategic locations
- Use of cellular telephones through 911 or designated "hot line"
- Ties with transit and taxi companies
- Aerial surveillance

TECHNIQUES FOR REDUCING RESPONSE TIME

- Cooperative agreements between responding agencies
- Equipment and materials located in strategic locations
- Development of key personnel resource list
- Tow trucks and other response vehicles stationed at high incident rate locations
- Peak period motorcycle patrols
- Development of freeway management team manual
- Improved interagency radio communication

EFFECTIVE ON-SCENE MANAGEMENT TECHNIQUES

- Advance alternate route planning
- Implementation of flashing lights policy
- Command posts and established procedures
- Development of hazardous materials manual
- Proper traffic control techniques at incident scene
- Proper parking of response vehicles at incident scene

TECHNIQUES FOR REDUCING CLEARANCE TIME

- Equipping response vehicles with appropriate materials and equipment
- Equipping response vehicles with push bumpers and establishing clear procedures for their use
- Off-freeway accident investigation sites
- Clearly identifying locations of fire hydrants accessible from the freeway
- Training for all response personnel on handling of various types of incidents

EFFECTIVE MOTORIST INFORMATION

- Media agreements
- Variable message signs
- Highway advisory radio

References

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4. Highway Capacity Manual, Transportation Research Board, Special Report 209, 1985.

5. Urban and Suburban Highway Congestion, U. S. Department of Transportation, Federal Highway Administration, 1987.